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GREAT WATERFALLS,
CATARACTS, AND
GEYSERS.



YOSEMITE FALLS, CALIFORNIA.

By
JOHN GIBSON

WITH 33 ILLUSTRATIONS

WILLIAM TOWN
-154-
CUMBERLAND STREET
GLASGOW

ALBANY ACADEMY,

CUMBERLAND STREET, WEST.

Session 1887/8

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Second Latin Class
2nd Division Arithmetic

— To —

Master C. E. Beardmore
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In memory of
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YOSEMITE FALLS, CALIFORNIA.

GREAT WATERFALLS
CATARACTS, AND
GEYSERS



FALL OF FELOU, SENEGAL RIVER.

Page 171.

Thomas Nelson and Sons,
LONDON, EDINBURGH, AND NEW YORK.

GREAT WATERFALLS, CATARACTS, AND GEYSERS,

Described and Illustrated.

By

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&c. &c.*

WITH 92 ILLUSTRATIONS

London:

T. NELSON AND SONS, PATERNOSTER ROW.
EDINBURGH; AND NEW YORK.

1887.

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GREAT WATERFALLS.

Introductory.

RIVERS are the channels by which the water taken from the ocean is returned to it. They take their rise in upland regions ; and coursing down hillsides, or rushing as rapid torrents through mountain gorges, they shape their course to the sea in accordance with the nature of the country they have to traverse.

“ See the rivers how they run,
Through woods and meads, in shade and sun ;
Sometimes swift, sometimes slow,
Wave succeeding wave they go.”

The most magnificent and awe-inspiring phase of a great river is when it descends suddenly from a higher to a lower level. There is nothing in the world comparable in terrific grandeur to such a fall as that of Niagara, unless it be the eruption of

a great volcano. Waterfalls on a scale at all approaching that of Niagara are exceedingly rare; but there are few rivers which in their course to the sea do not make more or less extensive leaps. These, if not always deserving the name of falls or cataracts, form at least considerable rapids, in which

“ A river, rushing swiftly towards the deep,
Has all its tossing current white with foam.”

Waterfalls are for the most part due to the fact that the river-bed is usually composed of rocks of different degrees of hardness, and the softer rock being worn away at a quicker rate than the hard, a step is formed where the two kinds of rock meet, and a waterfall is thus begun. The force of the water now falling on the softer rock wears it down more rapidly than when it merely flowed over it, and the fall thus tends to deepen. A somewhat similar cause gives rise to the recession observed in many waterfalls; thus Niagara has eaten its way back through seven miles of limestone and shale, while the Falls of St. Anthony on the Mississippi have receded nine miles. In the former case the shale, being soft, is quickly eaten into by the rebound of the water as it falls over Niagara, and the limestone above, thus losing its support, falls down in large blocks.

Cataracts and rapids, such as those of the Orinoco, are due to the presence of dikes of basalt or other hard igneous rock crossing the river; while the cataracts of the Nile are caused by granitic rocks in the bed of the stream. Granite, indeed, seems to be the rock, the presence of which in river-beds is the most frequent occasion of waterfalls and rapids. The Victoria Falls on the Zambesi, however, owe their origin to a totally different cause, being due to a convulsion of Nature, by which a rent right across the stream, fully a mile in length, eighty yards broad, and over a hundred feet deep, was made. Into this ready-made chasm the waters of the Zambesi poured; and as the rent was continued on the opposite side of the chasm at right angles to the fall, a way was thus opened up for the escape of the river.

Waterfalls are not permanent features of a river, but come to an end so soon as the running water has sawn through the obstructions producing them. The Falls of St. Anthony, which have already cut through nine miles of rocky strata, have only other six miles to deal with similarly, when they will be transformed into rapids; and geologists point to a gorge with walls three hundred feet high further down the Mississippi, which is believed to have been once the site of a waterfall that had thus sawn it-

self out of existence. If the Americans have thus lost a piece of imposing river scenery, they have gained much more in the navigability of the river.

Waterfalls and rapids are among the greatest hindrances to human intercourse and civilization. But for the Nile cataracts, for example, Khartoum could have been reached by steamer from Cairo in a few days, when Gordon could have been saved. If Africa has hitherto been "the dark continent," it has been mainly owing to the barriers placed in the way of reaching its interior by cataracts and rapids occurring near the sea end of its river courses. Africa has been described as "a table-land of lacustrine saucers one thousand to four thousand feet above the ocean level, with a rim of coast ranges one hundred to two hundred miles distant from the sea. The great rivers issue from the interior by gaps in the rim, and the steepness of the descent from each gap to the sea necessitates cataracts and falls." The Congo is an example in point: the Yellala Falls, at the head of the estuary of that river, and the series of cataracts and rapids that extend for nearly two hundred miles above them, shut out the trader from three thousand miles of navigable water occurring above the obstructions. To obviate this prime difficulty in carrying civilization into the heart of Africa, railways are needed; and a com-

pany has lately been formed for the construction of such a line to connect the Congo below Yellala with Stanley Pool—a distance of about one hundred and fifty miles.

Magnificent and even terrible as is the fall of an immense body of water over a precipice, it is probably excelled in beauty by the rise of water into the air from a geyser. Those hot-water fountains occur in three widely-severed regions of the globe—Iceland, where they have been longest known; the Yellowstone National Park of America, where they are in greatest abundance and vigour; and in New Zealand, where they appear to be dying out. These are all situated in volcanic regions, and are themselves a manifestation of volcanic activity, although, probably, a declining phase of it. It has been pretty conclusively shown that the source of the eruptive action of a geyser lies in the hot part of the pipe by which the water is ejected, and that steam is the eruptive force. After an eruption the water goes on accumulating until the conditions for another outburst are produced; and thus it is that the geysers are all intermittent in their action, some playing at intervals of half-an-hour, others resting for days.

Falls of Niagara.

“ O King of Floods ! that with resistless fate
Down plungest in thy mighty width and depth.
.....Amazement, terror, fill,
Impress, and overcome the gazer's soul.
Man's schemes and dreams and petty littleness
Lie open and revealed. Himself far less—
Kneeling before thy great confessional—
Than are the bubbles of the passing tides.
Words may not picture thee, nor pencil paint
Thy might of waters, volumed vast and deep ;
Thy many-toned and all-pervading voice ;
Thy wood-crowned isle, fast anchored on the brink
Of the dread precipice ; thy double stream,
Divided, yet in beauty unimpaired ;
Thy wat'ry caverns and thy crystal walls.”

By general consent Niagara is regarded as the greatest and grandest of waterfalls. Others there are whose waters fall from a greater height and amid surroundings that show them to greater advantage ; but in the grandeur that comes of sheer volume of overleaping water no cataract in the world can approach Niagara. Over the limestone cliff that forms its edge there falls into the gorge beneath—a gorge not more than one thousand feet in breadth—

the waters drained from well-nigh half a continent. Eighteen million cubic feet of water, it is estimated, are hurled every minute from this precipice, to be shattered into spray on the rocks beneath. No wonder that the Indians, as they gazed on the scene, should have called it Niagara—"the Thunder of Waters."

The river, of which this mighty cataract is the most notable feature, is a portion of that great chain of lake and river known as the St. Lawrence. It connects Lake Erie with Lake Ontario; and in its course of thirty miles it makes a total descent of three hundred and twenty-eight feet. On leaving Lake Erie the Niagara is about three-quarters of a mile broad, and flows at first somewhat swiftly. It then divides and passes round Grand Island, after which it broadens and assumes the tranquillity of a lake studded here and there with small islands. Narrowing again, it makes a long descent at the rate of fifty-two feet in the mile before finally "shooting Niagara."

The tumultuous rush of water down this steep descent forms the famous Rapids, which extend from the verge of the cataract half a mile up the river. Looking at them from the Prince of Wales Tower, on the Canadian side of the Falls, an eye-witness thus describes them: "So furious is the rapidity of the current that the centre is heaped up in a ridge-like

form, and the waves on every side suddenly leap up in the air like great fish, and fall down with a sullen sough. The wind comes sweeping over them, and drives their crests along the surface in showers of spray. Great logs, and trees burdened with all the glory of their branches, with their greenery still untorn, come sweeping down, taking leaps like greyhounds, and giving us the idea of independent life and motion." The difficulty of man or boat holding their own in such an angry torrent may well be imagined.

The rapids are still better seen from one of the bridges on the American side of the Falls. The numerous islets on that side, while they act as a foil to show more strikingly the headlong fury of the rushing waters, have frequently intercepted the downward progress of boats, which but for those friendly obstructions would have gone like arrows over Niagara. The difficulty with those who have escaped the most fearful of deaths by being thus shipwrecked on one of the islands in the rapids lies in getting to the mainland again.

In navigating the rapids, so as to save such persons, no one has ever shown the same skill and daring or has had the success of Joel R. Robinson, who has been dead now for nearly twenty years. On one occasion a mechanic named Chapin, engaged

in repairing the bridge to Goat Island, fell into the rapids. The fierce current bore him swiftly along towards the dreaded cataract, but as he was being carried past one of the small islands below the bridge he, being a good swimmer, made a desperate and happily successful effort to reach it. The island was only thirty feet square, and covered with cedars and hemlock. Worse than all, it was separated from the mainland by a channel that it seemed the veriest madness for any one to attempt to ferry across. Nevertheless, says Mr. Holley, the historian of Niagara, Robinson launched his light-red skiff from the foot of Bath Island, picked his way cautiously and skilfully through the rapids to the little island, took Chapin in, and brought him safely to the shore.

The breadth of Niagara before taking its tremendous leap is four thousand seven hundred and fifty feet, or about three-quarters of a mile. The fall of water, however, is interrupted in the centre by Goat Island, which rises forty feet above the water, and has a frontage of one thousand feet. This island, which is now connected with the shore by an iron bridge, contains less than seventy acres, although at one time, according to early records, it had an area of two hundred and fifty acres. It is a huge mass of boulder clay lying in the limestone

rock which forms throughout the bed of the Niagara, and it is being every year slowly eaten away by the erosive action of ice and water—those mighty agencies that are here seen at their mightiest.

Goat Island, ending in a sheer, dry precipice one thousand feet in length, divides the waters of Niagara into the two great falls—the Horseshoe and the American. The former is on the Canadian side, and has a length of nearly two thousand feet, which, however, is greatly increased if it be measured along the curve to which it owes its name. The American Fall is only half the length of the Horseshoe. Over these two cataracts, but mainly over the Horseshoe, falls every minute the inconceivably large quantity of eighteen million cubic feet of water—an estimate reached by ascertaining the velocity of the water and its depth before making the leap.

It may be of interest to state how the Americans once determined the latter point. The ship *Michigan*, having been condemned as unseaworthy, was purchased by a few speculators with the view of being sent over the Falls. In order to make this shooting of Niagara a financial success, it was widely advertised that the pirate *Michigan*, with a cargo of furious animals, would pass the great Rapids and the Falls of Niagara on the 8th September 1827. She would sail, the sensational an-

NIAGARA FALLS.



nouncement added, through the white-tossing and deep-rolling rapids of Niagara, and down its grand precipice into the basin below, affording a spectacle "unequalled in the annals of infernal navigation."

The attractive programme drew immense crowds, and the *Michigan* performed its part satisfactorily. "Her hull," says Mr. Holley, "was eighteen feet deep. It filled going down the rapids, and went over the Horseshoe Fall with some water above the deck, indicating that there must have been at least twenty feet of water above the rock." Of its cargo, all went over the fall except a bear, which left the doomed ship somewhere in the rapids, and succeeded in swimming ashore. Some geese that formed part of the live cargo were afterwards picked up below the Falls, not much the worse of their fearful plunge. A second ship that was started on a similar mission proved a failure, as she struck on a bar in the rapids, and remained there until broken up by the ice of the following winter.

The depth of water on the edge of the Falls differs, of course, with the condition of the river: thus, in the spring of 1847, a long-continued gale from the west drove the water down Lake Erie, and caused a rise of six feet in the waters of the rapids—the highest rise ever known in the river.

On the American side the height of the Falls is one hundred and sixty-four feet, while on the Canadian side it is fourteen feet less. Very conflicting accounts have been given of the noise made by the smash of waters over Niagara. In the first detailed account of it—that of Father Hennepin, who visited Niagara in 1678—it is described as “a great and prodigious cadence of water, to which the universe does not offer a parallel...The waters which fall from this great precipice do foam and boil in the most astonishing manner, making a noise more terrible than that of thunder. When the wind blows to the south its frightful roaring may be heard for more than fifteen leagues.” The fact seems to be that Niagara is at first disappointing both to the eye and the ear of the visitor. From the banks above the Falls their stillness and not their noise is the surprising thing. It is only when the spectator gets down into the gorge to close quarters with this mighty phenomenon that sight and hearing are fully gratified. Professor Tyndall accounts for the comparative quietness of the Falls on the adjoining banks as due, in part at least, to the lack of resonance, “the surrounding country being flat, and therefore furnishing no echoing surface to reinforce the shock of the waters.”

In order to comprehend the wonders of Niagara and to feel its full magnificence, the Falls must be watched for hours both from above and below ; and there is no lack of points from which the visitor may gaze his fill in comparative comfort. The Table Rock has always been the favourite position for obtaining a view of the whole of the Falls from above. It is on the Canadian side, and immediately in front of it is the Horseshoe Fall. The river here is deeper than on the American side—so deep, indeed, that as it passes over the ledge it is too solid to break into foam. It falls over as a continuous layer, and retains its green colour for some distance below the edge of the precipice. “The plunge of the water,” says Tyn-dall, “is not wild, but deliberate, vast, and fascinating.”

Previous to 1850 the Table Rock formed a better point of view, and better justified its name, than it does now. It was then a projection of limestone rock jutting out to a distance of two hundred to three hundred feet, with a breadth of sixty feet. In that year the greater part of it fell into the abyss below, reducing Table Rock to a mere narrow bench along the bank. The downfall took place about midday, and fortunately no lives were lost. An omnibus which stood on it was being cleaned

at the time by its driver. Feeling, however, the premonitory cracking of the rock, he had time to make his escape before the immense mass, two hundred feet in length, sixty feet in width, and one hundred feet deep, went down, carrying with it his omnibus.

On the American side the points of view are numerous. A little above this fall the channel is divided by Bath Island; and this is connected with Goat Island on the one side and with the American continent on the other by means of bridges. The Moss Islands, also known as the Three Sisters, are likewise connected by bridges with Goat Island. These are beautifully wooded spots, and are a favourite resort of tourists.

Connected with Goat Island, and built upon a rock on the very brow of the American Fall, there stood until lately the Terrapin Tower, from which the best view of this cataract could be obtained. Owing to its growing insecurity from the constant crumbling away of its foundations, the tower was removed in the year 1873.

This wasting of the rocks which form the precipice of Niagara constitutes one of the most important facts in its history. The bed of the river all the way from Lake Erie consists of hard limestone rock. Upon this the flow of pure, clear water, in

spite of its great volume and speed, has comparatively little wearing effect; for it has been observed that the surface of the rock in the river-bed still bears the marks of the ice-scratching impressed upon it during the Glacial Period. Beneath this limestone lies a bed of soft shale, which, equally with the limestone, is cut through and exposed in section at the Falls.

The limestone and the shale are each about ninety feet in thickness; and the latter is constantly crumbling away under the disintegrating influence of the spray violently blown against it by the wind, by the rebounding of the waters, and by the frosts of winter. The limestone above is being thus constantly undermined, with the result that the overhanging ledge, no longer supported from below, becomes at length unable to bear the weight of water above, and so breaks off, rolling into the gulf beneath, to be there pounded by ice and water into powder, and so carried down to the first great settling pool—Lake Ontario. There the deposition of solid matter that is taking place is seen in the sudden fall of the depth from seventy-two feet in the Niagara to twenty feet in that part of Lake Ontario where the river enters it.

Falls of rock due to this cause have been frequent during the two hundred years that the Nia-

gara has been known to civilized man. In 1818 at the American Fall, and in 1828 at the Horseshoe, there were collapses of rock which are said to have shaken the adjacent country like earthquakes. The greatest fall of rock on record occurred at the Horseshoe in February 1877. It extended from Table Rock for a distance of about fifteen hundred feet round the curve of the fall, and the mass that fell was at some points fifty to one hundred and fifty feet wide.

By far the greatest body of water falls over the Horseshoe, and it is here accordingly that its excavating power has been greatest. The result is that during the present century the Horseshoe Fall has so changed its shape as no longer to bear its name so appropriately as formerly. The Falls are thus working their way backwards towards Lake Erie. It is difficult to form an estimate of the rate of retrocession, one geologist estimating it at a yard and another at a foot per year.

Below the Falls the river flows through a deep gorge with steep, precipitous sides for seven miles, when it leaves the table-land and emerges on the plain, through which it meanders to Lake Ontario. No one can see this gorge without coming to the conclusion that the Falls of Niagara, when the river began to flow, were situated at the edge of

the table-land at Lewiston, and that they have sawn their way backward through those seven miles to their present position. If the rock has been abraded at an average rate of one foot per year, it must have taken thirty-five thousand years for this seven miles' retreat of Niagara.

The Falls may be seen from below on both sides. The visitor may even, if he chooses, get behind the water, and so make his way beneath an aqueous canopy. This is possible owing to the projection of the limestone rocks beyond the underlying shale; the water as it rushes over the ledge finally throwing itself about fifty feet beyond the base of the cliff. According to Father Hennepin's account, the dry space beneath the American Fall was in his time big enough for four coaches to drive abreast without being wet.

Access is obtained to the bottom of the Falls on the Canadian side by means of Barnet's Stair, beneath the Table Rock. Those who wish to go behind the Falls get encased in oilskin suits, with indiarubber shoes, the necessity for this waterproof covering being soon seen in the blinding spray with which the traveller is usually surrounded. The way at first is not difficult, and the rock-wall with its enclosures here and there of gypsum and quartz crystals, and with its patches of moss, ferns, and other

traces of scanty vegetation, may be examined. The further the traveller proceeds, the greater becomes the buffeting of the winds and spray, until even the boldest have to recognize that discretion is the better part of valour, and retrace their steps.

The Horseshoe Fall may also be approached by Biddle's Stair. This way descends from Goat Island, which separates the two falls, to the bottom of the precipice, and from thence access is obtained both to the "Cave of Winds" on the American side and to the Horseshoe on the Canadian side.

Professor Tyndall during his visit to the Falls went further along the Horseshoe than most travellers, and his description of what after all beggars all description is both vivid and accurate. He was the first visitor who succeeded in following the guide Conroy across a torrent which stands in the way of reaching a point almost beneath the green water of the Horseshoe Fall. On his first endeavour he was taken off his feet by the current, and was only saved by turning and flinging himself towards the bank he had quitted. Nothing daunted, he tried again and succeeded. He thus describes his further exploration: "We climbed over the boulders towards the thickest spray, which soon became so weighty as to cause us to stagger under its shock. For the most part nothing could be

seen ; we were in the midst of bewildering tumult, lashed by the water which sounded at times like the cracking of innumerable whips. Under this was the deep resonant roar of the cataract. I tried to shield my eyes with my hands and look upwards, but the defence was useless. My guide continued to move on, but at a certain place he halted and desired me to take shelter in his lee and observe the cataract. The spray did not come so much from the upper ledge as from the rebound of the shattered water when it struck the bottom. Hence the eyes could be protected from the blinding shock of the spray, while the line of vision to the upper ledge remained to some extent clear."

"On looking upwards over the guide's shoulder, I could see the water bending over the ledge, while the Terrapin Tower loomed fitfully through the intermittent spray gusts." After rounding the promontory on which the tower stood, they pushed on "amid the wildest commotion," till further they could not go. Again sheltered by the guide, he looked up and could see as before "the green gleam of the mighty curve sweeping over the upper ledge, and the fitful plunge of the water as the spray between us and it alternately gathered and disappeared."

A more popular place of resort for tourists is the "Cave of Winds" on the American side. The pre-

liminary difficulties of access are here smoothed away by the erection of bridges to connect the various boulders that bring the traveller to the shaly recess known as the "Cave of Winds." Here, when the wind blows from the south, the wall of falling water may be viewed in comfort; and here, when the sun shines on the falling waters, can best be seen that beautiful play of prismatic colours—those rainbows, born of spray, for which Niagara is famous. More usually, in this cave, all the winds seem striving for the mastery—hence its name—when all that can be done is to stagger through it drenched and blinded with spray. The spray, which rises like smoke from the foot of the cataract, forms, especially in the morning, white vapoury clouds over the chasm. These, wafted about in the sunlight, cause rainbows to appear and disappear in endless variety.

The waters of Niagara plunge into an abyss one thousand feet in width, and of great depth, although this is considerably lessened by the huge boulders of limestone which have at times been broken from the ledge of the precipice, and which are awaiting the grinding of the ice for their final removal.

No description of Niagara would be complete that did not refer to its winter aspect. After a



CAVE OF THE WINDS, NIAGARA.

few weeks of intense frost its appearance is altered well-nigh past recognition. Owing to the freezing of the feeders of Niagara the quantity of water poured over the cataract is greatly lessened; but what of grandeur is thus taken from it is compensated for by the fantastic ice-forms with which it becomes clothed.

Beneath the Falls there arise huge columns of ice that assume the most fantastic shapes, and along the banks ice-heaps grow to a height of fifty feet. The spray freezing on everything it touches gives to each bit of rock an ice-cap, and covers every tree, shrub, and blade of grass with a thick coating of ice-crystals that turn the islands immediately above the Falls into veritable bits of fairyland. The charming scene presented on Luna—a small island connected by a bridge with Goat Island—when everything is thus clothed in ice, has a fascinating weirdness added to it on moonlight nights by the constant presence of the lunar rainbow—a phenomenon nowhere seen so well as here.

The ice formed on the rocks below the American Fall has been known to go on thickening until it has reached the edge of the precipice. It is then usually appropriated to the peculiarly American sport of "coasting," when hundreds of both sexes, sitting or standing on sledges, may be seen speeding

down the icy declivity. Beneath the Falls ice-bridges are also formed, which in cold seasons are believed to reach a thickness of two hundred and fifty feet.

In the spring time the inevitable thaw comes, and with it a return of the full volume of water. The ice breaks up and is carried over the cataract, and as it forces its way down-stream to the waters of Lake Ontario, it, above all other agencies, grinds down and pulverizes the rocks over which it passes.

A curious and unique phenomenon connected with ice occurred on the Niagara in March 1848. A severe gale in Lake Erie had driven the ice towards the opening which forms the beginning of the Niagara river, and almost completely blocked the passage of the stream. The effect on the Falls was soon manifest. They quickly sank to the most modest dimensions, and the bed of the river was to a large extent laid bare. Mr. Holley states that he went lumbering with a log-cart and four horses on the rapids; and acres of clams and other shell-fish were exposed to the light. This stoppage of the waters lasted for the greater part of a day.

Instances have already been given of persons whose lives were saved when nearing the brink of Niagara, by their coming in contact with or reaching one or other of the numerous islands on the

NIAGARA IN WINTER.



American side. The narrowest escape of this kind was that of a man who, in 1852, fell from the Tower Bridge into the rapids, and was caught between two rocks just on the brink of the precipice—a position from which he was rescued in an exhausted condition by means of a rope. The number, however, who have not been thus fortunate, but who, having gone into the rapids, have been carried over the cataract, is very considerable, quite justifying the local belief that Niagara demands a yearly sacrifice of two human victims. It is needless to say that no one ever survived the awful plunge.

Instances have been known, however, of animals thus surviving. A bull-terrier, in 1858, was thrown into the rapids, and in less than an hour it came up the ferry stairs below the Falls. Birds have gone over and survived the plunge, but great numbers are thus killed. Ducks and other water-birds coming down the river on dark, foggy nights frequently shoot Niagara in hundreds, their dead bodies being picked up in the gorge below.

After leaving the chasm into which the waters plunge from the ledge one hundred and sixty feet above, the river makes its way for seven miles through a deep ravine, from two hundred to three hundred and fifty feet in height, and from three hundred to

one thousand feet in breadth. It may be crossed at three points during the first two miles of its course. Not far below the Falls is a ferry connecting the American and Canadian sides. A little further down is the Upper Suspension Bridge, for foot and carriage passengers. It stands one hundred and ninety feet above the water, and, next to the Brooklyn Bridge, is the largest structure of the kind in the world, being twelve hundred feet in length.

Two miles below the Falls the river is spanned by the Railway Suspension Bridge, in which the tubular system is combined with that of the suspension bridge. There is a carriage-way on a level with the top of the banks, and eighteen feet above this is placed the railway track, the whole forming a fine example of strength combined with grace. This bridge had a remarkable wave-like motion imparted to it by a fall of rock in 1863. A mass of rock, estimated to weigh five thousand tons, broke from the side of the river gorge, forty rods below the bridge, and fell with a crash on the solid rock two hundred and thirty feet beneath it. The shock thus produced made itself so distinctly felt on the bridge that a number of workmen employed on it at the time rushed off in alarm.

Throughout its course between ferry and bridge

the river flows almost unruffled ; below this, however, the gorge narrows, the descent becomes greater, and the turbulence of the water increases. With the waters of half a continent confined to a channel not much more than three hundred feet in width, and that channel with a considerable fall, the impetuosity of the current may be imagined. The galloping and tumbling of the waters is most violent in the centre of the stream ; and this has been supposed to be due to the presence of boulders or other huge obstacles in mid-channel, the impact of the water against which gives rise to those " vast pyramidal heaps that leap incessantly from the river, some of them with such energy as to jerk their summits into the air."

These lower rapids do not end like the upper ones, already noticed, in a cataract, but in a whirlpool. The river, which has been flowing in a north-west direction, suddenly bends eastward, hurling its waters with tremendous force against the opposing bank. The river has there scooped out a circular basin through which its waters course in furious eddy, with a never-ending succession of whirlpools forming and breaking up, only to be formed again. " Within the basin," says an eye-witness, " the waters are rushing onward, plunging downward, leaping upward, combing over at the top in beautiful

waves and ruffles of dazzling whiteness, shaded down through all the opalescent tints to the deep emerald at their base."

The power of the whirlpool is seen by watching the behaviour of logs of wood that are borne into it from the rapids. The trunks of trees, two or three feet in diameter and fifty feet long, perform the circuit of the pool like very straws, and may then be seen to be drawn down endwise in the whirl, to be ejected a few minutes later with great force, and bearing evidence in their torn and tattered appearance of the rough treatment they have received. They do not, however, as a rule, yet escape into the calm waters beyond; for being caught again in the rotating current, they continue circulating above and beneath this furious eddy, it may be for weeks, before a happy combination of circumstances shoots them down-stream.

Once, and once only, has the navigation of the rapids and the whirlpool been attempted. Joel Robinson, the courageous and successful navigator of the rapids above the Falls, became captain of the *Maid of the Mist*, a small steamer which for some years took passengers from both sides of the river up to the Falls. Having become unprofitable, the owner was offered a good price for the steamer, provided he would deliver it at the town of

Niagara, situated some distance below the whirlpool.

Robinson agreed to make the attempt, and on the afternoon of June 15th, 1861, the perilous trip was begun, the entire crew, besides Robinson, consisting of the engineer and another man to assist at the wheel. The voyage was watched by thousands from both shores and from the bridge. "With a shriek from her whistle and a white puff from her escape pipe," says Holley, "the boat ran up the eddy a short distance, then swung round to the right, cleared the smooth water, and shot like an arrow into the rapids under the bridge.

"Robinson intended to take the inside curve of the rapids, but a fierce cross-current carried him to the outer curve, and when a third of the way down it, a jet of water struck against her rudder, a column dashed up under her starboard side, heeled her over, carried away her smoke stack, threw Robinson flat on his back, and thrust his companion against the starboard wheel-house with such force as to break it through. Every eye was fixed, every tongue was silent, and every looker-on breathed freer as she emerged from the fearful baptism, shook her wounded sides, slid into the whirlpool, and for a moment rode again on an even keel. Robinson rose at once, seized the helm, set her to the right of the large

pot in the pool, then turned her directly through the neck of it. Thence, after receiving another drenching from its combing waves, she dashed on without further accident to the quiet bosom of the river below Lewiston. Robinson's terrible experiences during this short but perilous voyage cured him of any desire to win further laurels in this field, and he forthwith abandoned his life on the Niagara."

Daring as was this voyage through the whirlpool rapids, it was altogether eclipsed in reckless daring by the feat which, in 1883, cost Captain Webb his life. Webb had succeeded in swimming across the English Channel, and looking out for fresh aquatic fields to conquer, he conceived the idea of swimming over the course successfully passed through by the *Maid of the Mist*.

Although regarded by all acquainted with the place as foolhardy in the extreme, the captain was not to be deterred from the venture, and on the afternoon of July 24, 1883, he entered the water a mile and a quarter above the whirlpool. In five minutes' time he passed under the Suspension Bridge, fully a mile from the starting-point. Immediately below the bridge the river becomes exceedingly violent; as the water was clear, however, every movement of Webb could be seen. At one moment, according to an eye-witness, he was lifted high on



THE WHIRLPOOL, NIAGARA.
Scene of the Death of Captain Webb.

the crest of a wave, and in the next he sunk into the awful hollow created. He was apparently still swimming with ease and confidence. A quarter of a mile below the bridge the river reaches its narrowest, and from this point to the whirlpool the fury of the river baffles description. Sometimes Webb would be struck by a wave, and for a few moments would sink out of sight. He, however, rose again to the surface without apparent effort, and the spectators invariably drew a breath of relief. Once he was drawn under by the current, and when he rose he was one hundred and fifty yards from the spot where he sunk. His speed momentarily increased, and he was whirled along at a frightful rate.

When he reached the point at which the attractive power of the whirlpool is first felt, he sunk, and a cry of despair went up from the spectators. He emerged again, however, in comparatively smooth water, and at last was seen to approach the sublimely terrific whirlpool. Webb swept into the neck of the whirlpool. Rising on the crest of the highest wave, his face towards the Canadian shore, he lifted his hands once, and then was precipitated into the yawning gulf. For one moment his head appeared above the angry waters; but he was motionless, and apparently at the mercy of the

furious eddies. He paused, as if to decide on what course to take; but the current decided for him. He was again drawn under the water, and was seen no more alive. His body was found some time after below the whirlpool. On examination it was found that no bones were broken, nor were any symptoms of death by drowning revealed. Death, it may be supposed, therefore, resulted from the shock to his nervous system, sufficient in this case to have at once stopped all vital action.

In August 1886 a cooper named Graham, fired by the example of Webb, determined to risk the passage of the rapids in a novel fashion. He built for himself a barrel seven feet high, with a diameter of twenty-three inches. The staves were of oak, two and a half inches thick, and were bound together by thirty-four iron hoops. This curious vessel was so ballasted that it would swim upright, and had a man-hole in the top. A sack on the side for the body was stayed with short ropes. The course of the barrel was very erratic. After it was submerged, it scarcely ever remained upright, and was dashed about with tremendous violence. It escaped, however, being driven upon the rocks or being detained in the whirlpool. When Graham ventured to open the man-hole, when his dangerous journey was over, he emerged dizzy but unharmed.

A few days later, he again trusted himself and his barrel to the wild waters, but this time with his head exposed; and again he succeeded. Two days later, a man named Kendall, guarded by a cork-vest, swam the rapids successfully for 1,000 dollars. His experience was such that nothing in the world, he said, would tempt him to try the rapids again.

An equally reckless feat, and one which ended fatally, was that of jumping from the Suspension Bridge into the swift current below, a distance of one hundred and ninety-two feet. The man who first tried this mad leap turned over twice during the descent, and falling flat on the water was killed. The second, more cautious, wore a harness over his shoulders to which a wire was attached that ran loosely over a cylinder on the bridge. That enabled him to keep his feet straight towards the water, and in four seconds he reached its surface in safety.

Among other feats of daring that have been witnessed at Niagara, one of the most sensational was the crossing of it by M. Blondin on a tight-rope. Permission was at first refused to the daring Frenchman; but at last he was allowed to place his rope across the chasm just below the railway bridge. The rope was two inches in diameter, and had attached to it stays of small rope stretched from either side.

On this spider-weblike bridge the acrobat safely crossed the Niagara. To this pedestrian feat he soon added others of a much more astounding kind, such as hanging from the cable by his hands and feet, standing on his head, lowering himself to the water's edge, walking over in a sack, trundling a loaded wheelbarrow, and carrying a man across on his back. In 1860 M. Blondin performed at Niagara before the Prince of Wales.

Professor Tyndall considers it probable that the Niagara Fall has all along its course from Lewiston been of horse-shoe form. It is indeed difficult to understand how, with the greatest body of water in mid-channel, it could be otherwise; for here the greatest amount of erosion would take place. The erosion of the American Fall is but slight compared with that of the Horseshoe; and when the latter, in the course of a few thousand years, shall have cut its way higher up than Goat Island, it will inevitably drain the American branch of the river as well. The American Fall will then become a dry precipice overhanging a second whirlpool, which will doubtless be formed at the bend where the present Falls are, and the Niagara waters will plunge, as they have doubtless often done before, over a single cataract of horse-shoe shape.

Niagara has hitherto been regarded simply as

one of the world's wonders—a thing to be looked at with awe and admiration. The day, it is hoped, may yet come when the gigantic force that wantons here in idleness may yet be harnessed by man and made to do useful work in the world. The late Sir W. Siemens computed that over Niagara a hundred million tons of water fell every hour through a vertical height of one hundred and fifty feet, giving 16,800,000 horse-power, the only result being the raising the temperature of the water by one-fifth of a degree Centigrade. By means of dynamo-electric machines it is now possible to turn the energy of falling water into electricity. The latter can be transmitted long distances by wire, and re-converted at its destination either into light or motive-power. There is sufficient energy in the Niagara Falls, could it be made available, to supply motive-power for a whole continent.

Falls of Yosemite Valley.

NEAR the centre of the State of California, and buried among its highest mountain peaks, lies the Yosemite Valley, which, in grandeur, sublimity, and beauty, is probably unequalled in the world. It is about one hundred and fifty miles east of San Francisco, but does not appear to have been seen by European eyes till the year 1851.

The white settlers in the neighbouring Mareposa were harassed from time to time by the depredations of the surrounding Indians. They at length organized a military expedition, pursued the Indians into their fastnesses, and discovered the Yosemite. The aborigines have now disappeared, and the Government of the United States has ceded the valley to the State of California on condition that it be kept for ever as a national park. The trail of the Indian has given place to the substantial wagon road; the wigwam and the Indian have disappeared before the hotel and the tourist.



The valley is only eight miles in length and half a mile in breadth, yet in this comparatively limited space are crowded a greater number and variety of natural wonders than anywhere else on the globe. It is a vast hollow, nearly a mile in depth, the sides of which are everywhere abrupt and precipitous, as if the whole were the result of a sudden rent in the surrounding mountains.

Through it there flows the Merced, a river about seventy feet wide and twelve feet in depth; while from either side of the valley streams that take their rise in the snow-capped mountains around, rush down its steep sides, and form in their courses the waterfalls that are the chief glory of the Yosemite Valley. In its course through the valley the Merced has a fall of only thirty-one feet; but in the previous two miles of its course it makes its descent through rugged cañons of nearly two thousand feet. By another cañon it leaves the valley to join the San Joaquin.

Entering the valley from the west the traveller finds objects of interest crowding upon him on either side. If the season be early summer, the melting of the snows on the high peaks will have swollen the streams into roaring torrents, and the waterfalls will be seen at their best and fullest. On his left is the Ribbon Fall, which the drought

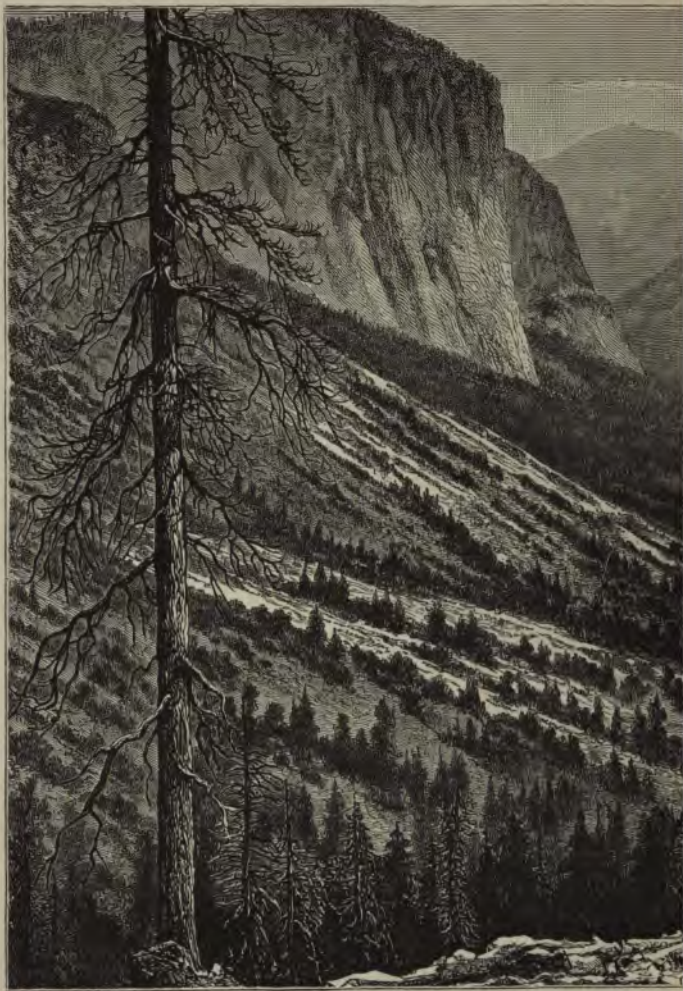
of summer will all but extinguish, but which, fed by the melting of winter snows, presents a lively appearance as it rushes down the face of rocks from two to three thousand feet in height.

Near the Ribbon Fall is that most imposing of rocks, "the Captain," a vertical cliff three thousand three hundred feet in height; and nearly opposite to it, on the south side of the Merced, is the Bridal Veil Fall. The stream, which here takes a leap of nine hundred feet, rises in a lake thirteen miles off. The waters of this mountain tarn, lashed into fury by the winds, leap and break into foam around a rock that rises in its centre. Many an Indian has lost his life in its turbulent waters; and there are traditions of individuals having fallen into the rapid stream that leaves it and been carried over the fall by which it plunges into the Yosemite Valley.

The fall is, therefore, in bad repute with the Indians, who call it the "Spirit of the Evil Wind," and they will neither pitch their camp nor on any account go to sleep within sound of its falling waters. "To point the finger at these falls," says Dr. Todd, "is certain death, as they believe. They hear the voices of those who have been drowned there whenever they hear the sound of these falls."

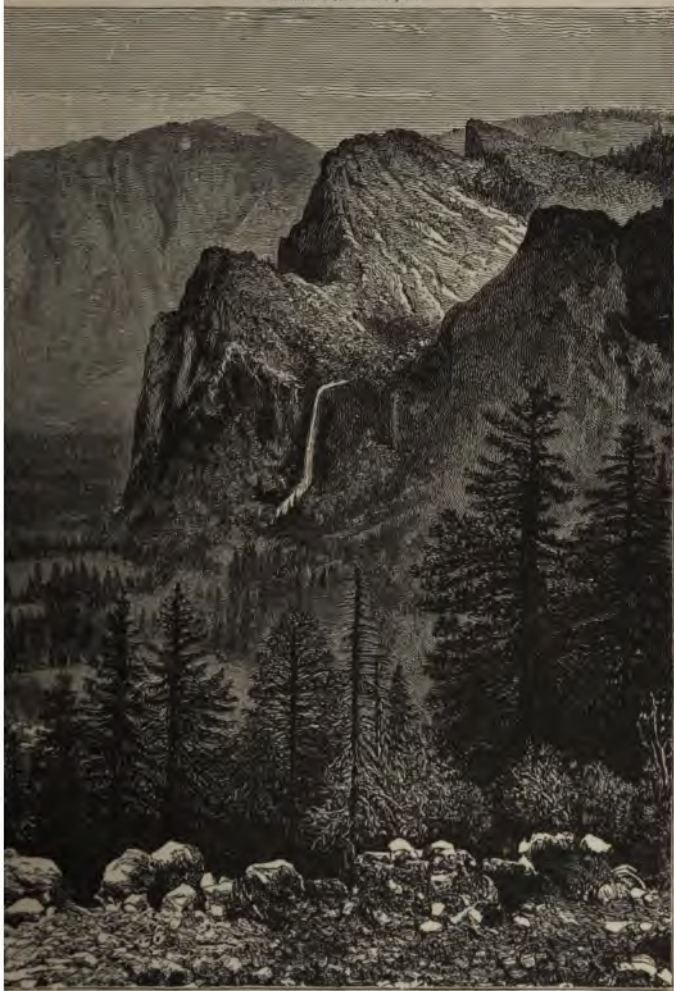
The body of water is not very large; consequently

El Capitan.



GENERAL VIEW

Bridal Veil Waterfall.



ITE VALLEY.

as it falls through nearly one thousand feet it thins out into a gauze-like sheet, which as it waves backward and forward in the wind gives it the white veil-like appearance to which it owes its name. The stream before it takes the leap is about forty feet in width; its waters are broken into spray ere they reach the bottom, and are further shattered into a smoke-like mist by concussion with the rocks below. A vapoury screen is thus formed on which the sun is ever painting the prismatic hues of the rainbow.

Passing eastward from Bridal Veil Fall the traveller encounters those huge granite buttresses, known as the Cathedral Rocks, with the great granite columns, sharp and bare, rising behind them, and appropriately termed the Cathedral Spires. Further on, and near the centre of the valley, is the Sentinel Rock, which rises like some great watch-tower to a height of three thousand two hundred feet; and nearly opposite are the Yosemite Falls.

These in the season of melting snows are grand beyond description, their leading features being thus described in Professor Whitney's "Geological Report of California":—"From the edge of the cliff to the bottom of the valley the perpendicular distance is in round numbers two thousand five hundred and fifty feet. The fall is not one perpendicular sheet.

There is first a vertical descent of fifteen hundred feet, when the water strikes on what seems to be a projecting ledge, but which is in reality a shelf or recess, about a third of a mile back from the front of the lower portion of the cliff. Across this shelf the water rushes downward in a foaming torrent on a slope equal to a perpendicular height of six hundred and twenty-six feet; after which it makes a final plunge of about four hundred feet on to a low talus of rock at the foot of the precipice.

“As these various falls are in one vertical plane, the effect of the whole from the opposite side of the valley is nearly as grand, and perhaps even more picturesque, than it would be if the descent were made in one sheet from the top to the bottom. The mass of water in the fifteen hundred feet fall is too great to allow of its being entirely broken up into spray; but it widens very much as it descends, and as the sheet vibrates backward and forward with the varying pressure of the wind, which acts with immense force on this long column of water, the effect is indescribably grand.”

The Yosemite Falls are somewhat dwarfed by their own height. To the onlooker in the valley the sheet of water, as it leaps from the cliff about half a mile in perpendicular height above him, seems only to be a foot or two in breadth; whereas those



THE BRIDAL VEIL FALL.

who scale the height find it to be forty feet wide at the top. The river into which it gathers before joining the Merced is, in seasons of abundant water, forty feet wide and seven feet deep at the bridge.

In winter a curious transformation is sometimes wrought by ice on these falls. The spray freezes around the base, and with the continuance of frost the pile of ice rises as a hollow column to the height of several hundred feet. With the breaking up of the ice in spring there comes a moment when the roar of the cataract ceases; the unwonted silence brings the dwellers in Hutching's Hotel to the doors, when they are just in time to see the close of the struggle between the fettering ice-column and the fall of water. The ice gives way and is dashed into atoms that glisten for a moment in the sun, and are then swept away by the torrent.

Proceeding up the valley to its head, the Yosemite is seen to divide into two cañons. At the entrance to the northern fork is the highest of the Yosemite peaks—the Half Dome—five thousand feet above the river, and nine thousand feet above the sea; opposite it is the North Dome; while between the two lies the Mirror Lake, the clear, calm waters of which reflect as in a mirror the surrounding landscape.

Through the southern fork flows the main branch of the Merced, and in its course there are falls which, especially in volume of water, excel all others in the Yosemite Valley. The first of these, the Vernal Falls—or the “Cataract of Diamonds,” as the Indians call it—is reached after an ascent of two thousand feet.

The Merced here leaps over a “perfectly square-cut mass of granite” and falls to a depth of four hundred feet. As this is no mere tributary torrent, but the main stream, the volume of water is at all times great, and the effect is correspondingly magnificent. After the Vernal Falls, with their drenching spray and beautiful rainbow effects, have been sufficiently enjoyed from their base, a splendid view of them can be had from above.

Against the perpendicular side of the cliff a ladder has been raised by which the ascent to the edge of the cataract is made comparatively easy. Dr. Todd recommends those who ascend this ladder to keep the left eye closed, so as to shut out the view of “space, and the falls, and death.” The doctor, after successfully making the ascent, was at first inclined to plume himself on his courage and steadiness of nerve. On returning to the hotel, however, a refined and delicate lady casually informed him that she once went up that ladder with



THE VERNAL FALLS, YOSEMITE VALLEY.

no other company but her baby, which she tucked under her arm.

On reaching the top by means of the ladder, the brink of the precipice can be safely approached, there being a convenient parapet of rock from which the falling sheet of water can be seen throughout. Continuing the journey for half a mile up-stream the last and grandest of the Falls is reached. This is the Nevada Fall, which, while equalling the Vernal in its volume of water, far exceeds it in the extent of its descent. The river precipitates itself from a height of six hundred and forty feet, and near its summit it has a peculiar twist, caused by the mass of water falling on a projecting ledge which throws it off to one side, and thereby adds greatly to the picturesque effect.

Those who have seen this fall unite in considering it one of the finest in the world. Says Dr. Todd: "I unhesitatingly pronounce it the most beautiful water-view I ever beheld. It unites strength, power, and majesty with every outline of beauty. It seemed to quiver in its own song as it tossed its myriads of diamonds high in the air, shooting out masses of jewels, as the rocket sends out its brilliant creatures in the night. I feel sure that its equal for beauty cannot be found on the face of the globe."

It must be ranked, says another observer, as one of the finest cataracts in the world, taking into consideration its height, the volume and purity of the water, and the whole character of the scenery which surrounds it. The scenery around is indeed wildly picturesque, with the "Cap of Liberty"—a grotesque mass of granite two thousand feet above the level of the falls—rising to the right, and Mount Starr King to the left, while all around are heights and depths "grand to look up to, terrible to look into."



NEVADA FALL. YOSEMITE VALLEY.

Falls of the Yellowstone Region.

ANOTHER American Wonderland, and one on a much larger scale than the Yosemite Valley, is the Yellowstone Region, in the Rocky Mountains—a region of geysers, mud-volcanoes, and hot springs, of deep cañons and lofty waterfalls. The United States Congress, in the exercise of a wise forethought, withdrew it many years ago from settlement, and dedicated it as a great National Park or pleasure ground for the benefit and enjoyment of the people.

The National Park is in the form of a rectangle, measuring sixty-five miles by fifty-five miles; three hundred and thirty square miles of which is occupied by the Yellowstone Lake. The entire area is more than six thousand feet above the level of the sea, and it is surrounded by mountain ranges that rise to twice that height. Owing to its elevation frost occurs every month of the year; but during June, July, and August the climate is pure and most invigorating, with scarcely any rain or storms.

In recommending the scheme to Congress Dr. Hayden remarks: "This whole region was in comparatively modern geological times the scene of the most wonderful volcanic activity of any portion of our country. The hot springs and the geysers represent the last stages—the vents or escape-pipes—of these remarkable volcanic manifestations of the internal forces. All these springs are adorned with decorations more beautiful than human art ever conceived, and which have required thousands of years for the cunning hand of Nature to form."

The National Park is traversed by the Yellowstone River, which has its source, not far off, in a lake situated among the Rocky Mountains of Wyoming. It enters the reserved area at its south-west corner, and has not gone far until it is merged in the Yellowstone Lake, a beautiful sheet of water, at first sight of which Dr. Hayden exclaimed, "Such a vision is worth a lifetime, and only one of such marvellous beauty will ever greet human eyes!"

The river leaves the lake at its north-east corner in a channel a quarter of a mile wide, and deep enough, it is said, to swim a horse. The next twenty miles of its journey is through a region abounding in all sorts of volcanic phenomena; but



UPPER CATARACT OF THE YELLOWSTONE.

as yet the river gives no sign of the wild career it is about to enter upon.

Immediately above the Upper Falls it flows through a grassy, meadow-like valley, with a calm, steady current. As it approaches the brink the stream narrows, the waters get heaped up between the converging walls of one of the mightiest ravines in the world—the Grand Cañon—and with a mighty rush they leap clear out into the air, and then fall with a terrific thud on the rocks one hundred and forty feet below.

Midway in its descent the water falls upon a sloping ledge which projects, and it is thereby carried twelve or fifteen feet beyond the vertical base of the precipice. The sheet of water thus driven forward looks like a white fan or inverted wedge. "From any point of view," says Dr. Hayden, "the Upper Falls are extremely picturesque and striking. The entire volume of water seems to be, as it were, hurled off the precipice with the force which it has accumulated in the rapids above, so that the mass is detached into the most beautiful snow-white, bead-like drops, and as it strikes the rocky basin below, it shoots through the water with a sort of ricochet for the distance of two hundred feet. The whole presents in the distance the appearance of a mass of snow-white foam. On the sides of the

basalt walls there is a thick growth of vegetation nourished by the spray above, which extends up as far as the moisture can reach."

The river is now deep down in the cañon, through which it flows for another half-mile over a series of small rapids, when the presence of another basaltic dike crossing the stream at right angles gives rise to another and much more imposing cataract. The Yellowstone descends about sixty-eight feet in its short run between the falls.

As it nears the second precipice its waters are again heaped up by the narrowing channel; and flowing solidly to the very edge, the entire mass plunges over the descent of three hundred and fifty feet. It falls with a dull thud into a circular basin which it has excavated for itself out of the hard rock; and the rebound, says an observer, is the magnificent feature of the scene. Dr. Hayden considers it a sight far more beautiful than, though not so grand or impressive as, Niagara.

From the water at the foot a heavy mist always rises, so dense that it cannot be approached within two hundred or three hundred feet, and even there a few minutes suffice to drench the clothes of the curious spectator. Lord Dunraven regarded the Upper as the more beautiful of the falls, being more instinct with life, motion, and variety than



LOWER CATARACT OF THE YELLOWSTONE.



the other ; the Lower, however, he says, is by far the more impressive.

He thus describes the scene as he viewed it from a little promontory partially overhanging the brink : " The dark masses of water, casting themselves continuously over the ledge, string out into long, perfectly white threads of glistening air-bubbles and foam, and long before they reach the surface beneath, seem to be entirely dissolved into fine spray and rain ; but it is not so, for at the repeated shock of their concussion earth and air tremble. From the misty depths below, the roar of the water constantly arises in distinct vibrations like the humming of a harp string, and the steam floats up for ever in great clouds."

The descent to the foot of the fall is difficult, being over steep precipitous cliffs and sloping rock *débris*. Colonel Barlow made the descent in order to explore the cañon ; and as he stood at the foot of the fall, three hundred and fifty feet below its crest, his first impression was one of disappointment. It did not appear so high as he expected, owing no doubt to the much higher walls of the cañon, which rose to a height of seven hundred feet on both sides of him. The fall, however, he adds, was grand, and presented a symmetrical and unbroken sheet of white foam, set in dark masses of

rock, while rainbows were formed in the spray from almost every point of view.

More impressive to most visitors even than the falls is the mighty ravine through which the river flows. The Grand Cañon, with its sides from twelve hundred to two thousand feet high, is a mighty monument to the erosive power of water. The vast volcanic deposits of lava, scoria, and ashes which compose the Yellowstone region have been gradually excavated by the flow of the river, until the latter appears to the spectator as he looks at it from above dwarfed to a mere silver thread.

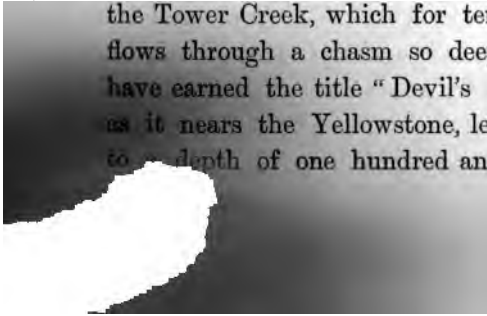
Successive layers of rock, of divers colours and different hardness, thus exposed, have been acted upon by all the atmospheric agencies, with the result that they have assumed most fantastic shapes. Spires, pinnacles, and isolated peaks, round towers, and square castellated masses of indurated clays, alternating with sharp angular fragments of more closely textured rock, are left standing erect upon the slopes. Some of the springs have formed crooked horns and protuberances in the smooth surface. In places the precipice is coated with lime, dazzling white; in others, the deposit is of delicately crystals of sulphur. Springs of water carrying iron and sulphate of copper are numerous, and painted the cliff in long streaks of colour.

It is not surprising that, in view of this scene, Dr. Hayden should have felt that no language could do justice to the wonderful grandeur and beauty of the Grand Cañon. Few Englishmen have yet seen and described these wonders; consequently most of the descriptions that have appeared are by Americans. No more glowing account or better word-painting of the Grand Cañon is to be found than that given by Dr. Archibald Geikie, the Director-General of the Geological Survey of Great Britain, who visited the region in 1879:—

“ We spent a long day sketching and wandering by the side of the cañon. Scrambling to the edge of one of the bastions, and looking down, we could see the river far below, dwarfed to a mere silver thread. From this abyss the crags and slopes towered up in endless variety of form, and with the weirdest mingling of colours. Much of the rock, especially of the more crumbling slopes, was of a pale sulphur yellow. Through this groundwork harder masses of dull scarlet, merging into purple and crimson, rose into craggy knobs and pinnacles, or shot up in sheer vertical walls. In the sunlight of the morning the place is a blaze of strange colour, such as one can hardly see anywhere save in the crater of an active volcano. But as the day wanes the shades of evening, sinking gently into the

depths, blend their livid tints into a strange, mysterious gloom, through which one can still see the white gleam of the rushing river, and hear the distant murmur of its flow. Now is the time to see the full majesty of the cañon. Perched on an outstanding crag, one can look down the ravine and mark headland behind headland mounting out of the gathering shadows, and catching up on their scarred fronts of yellow and red the mellower tints of the sinking sun. And above all lie the dark folds of pine sweeping along the crests of the precipices, which they crown with a rim of sombre green. There are gorges of far more imposing magnitude in the Colorado basin; but for dimensions large enough to be profoundly striking, yet not too vast to be taken in by the eye at once, for infinite changes of picturesque detail, and for brilliancy and endless variety of colouring, there are probably few scenes in the world more impressive than the Grand Cañon of the Yellowstone."

Near the lower end of the Grand Cañon the Yellowstone receives on its left bank a tributary, the Tower Creek, which for ten miles of its course flows through a chasm so deep and gloomy as to have earned the title "Devil's Den." This stream, as it nears the Yellowstone, leaps over a precipice to a depth of one hundred and fifty feet, forming





THE TOWER FALL, YELLOWSTONE REGION.

the Tower Falls, unequalled by any in this region for weird picturesqueness.

Columns of volcanic breccia, some resembling towers, others the spires of churches, and others tall and slender like the minarets of a mosque, rise from the base of the fall to a height of fifty feet. They stand, says Dr. Hayden, like gloomy sentinels, or like gigantic pillars at the entrance of some grand temple. One could almost imagine, he adds, that the idea of the Gothic style of architecture had been caught from such carvings of Nature.

Kaieteur Fall.

IN the year 1870, when Mr. Charles B. Brown, a member of the Geological Survey of British Guiana, was exploring the wild region in which the river Essequibo and its tributaries take their rise, he came quite unexpectedly upon a great fall unknown before to Europeans. The natives called it *Kaieteur*. He was much struck by its beauty and grandeur, and subsequent visitors have fully confirmed his impressions.


Lieutenant-Colonel Webber, who visited the fall some time after, was fortunate enough to see it in its full glory, lit up by a brilliant sun, the rays of which, playing upon the mist rising from its foaming basin, formed an immense rainbow. His first impression as this sight burst upon him caused him to exclaim, "This is far grander than Niagara." "What," he says, "the Kaieteur loses from a comparison with Niagara in width and in magnitude of the descending flood, it gains in height; while the ending scenery is far lovelier."

Mr. Brown returned to Kaieteur in the following year, and made a full survey of the fall, and the present account is largely taken from his report on the subject. The fall is situated on the Potaro river, a branch of the Essequibo, which, rising in the Ayangcanna Mountain, forty miles to the southwest of the fall, flows from an uneven plateau down a succession of immense cataracts to an extensive table-land. These cataracts, he found on inquiry at the Indians, taken together, give a fall almost as great as Kaieteur itself.

The table-land over which the Potaro flows is composed of sandstone and conglomerate, and this it leaves to plunge into a deep valley with a total fall of eight hundred and twenty-two feet. This plunge forms the great Fall of Kaieteur—a fall which closely resembles the Niagara in its mode of formation. The great American cataract passes over hard limestone rocks which are underlaid by softer shales. The latter are wasted away by the action of the rebounding water, and the hard limestone above, being thus slowly undermined, falls gradually away, and so Niagara is ever receding. At Kaieteur, the conglomerate at the surface, which has a thickness of about twenty feet, is an extremely hard rock, while the sandstone beneath is much softer. The same wasting process is therefore going on at Kaie-

teur Fall that has been proceeding for ages at Niagara, and there is evidence that the waste of rock produced by the action of the water has in this case caused the fall to recede nearly two miles.


Above the fall the river has no great force of current until within two hundred yards of the precipice, when the water moves with greater speed and becomes slightly rippled, breaking into little patches of foam here and there as it nears the edge. The width of the river at a distance of two hundred yards above the fall is one hundred and thirty-four yards; but at the edge of the fall it has narrowed to one hundred and twenty-three yards. The depth of water was found to be fifteen feet two inches; the level of the water, however, at that time was five feet below its highest level when in flood.

Over the lip of the precipice the water falls seven hundred and forty-one feet as a perpendicular column into the basin below, from which it continues to rush headlong over a sloping cataract in front to a further depth of eighty-one feet. As this vast body of water curves over the precipice, it is, says Mr. Brown, "of a dark reddish-brown colour in its deepest portions, through which can be seen patches of foam forming beneath and  to the surface of the water, ch

heavy column of foam of a white colour, with a slight reddish tinge." When this huge, continuous column of jagged foam beats into the basin below, "dense masses of spray spurt upwards in all directions, while the actual contact is rendered indistinct by clouds of mist."

The journey to the great Fall of Kaieteur from Georgetown, the capital of British Guiana, is a most difficult one. Mr. Brown and his party probably selected the easiest route when they approached it by water, sailing up the Essequibo and Potaro rivers. Navigation on both of these is, however, sadly interrupted by frequent cataracts and rapids of a more or less formidable character. In most cases it was found possible to drag the boats through those obstructions, but sometimes the boats had to be taken ashore and drawn uphill to smoother water.

On the fifteenth day of their journey they entered the valley which has been cut out by the Kaieteur Fall acting through untold ages, and when the sun came out and dispelled the mist and fog clinging to the mountain gorges, they saw the object of their visit at the head of the valley pouring its foaming water over the precipice. When within a quarter of a mile of it they reached a spot from which probably the best view of the actual fall and of the precipices on either side is to be obtained.



Here in a sort of cave they slung their hammocks for the night, with the fall in front of them, and the ceaseless roar of its waters sounding in their ears. As they sat by the fire that night the Indian who acted as interpreter related to them the tradition to which the fall owes its name. The following is the story as told by Mr. Brown:—

“Once upon a time” there lived an old Indian at a village above the fall, an exceedingly feeble old man, whose feet became infested with chigoe fleas to such an extent that he gave his friends and relatives an immense amount of trouble in picking them out for him every morning. So they determined to rid themselves of the nuisance, and accordingly placed the old man in a woodskin just above the edge of the fall, and shoved it out into the stream. The strong current hurried him to the brink and swept him over its foaming water, and he was seen no more. But not long after, strange to relate, his woodskin appeared at the end of a small island, in the smooth stream just below our camp, in the form of a long slab of rock; while on a slope on the right hand side of the fall, a large square rock represents his canister similarly petrified. After this tragedy had been enacted, the Indians named the fall Kaieteur, which means “old-man-fall.”

To get to the foot of the fall along the edge of the river was a task of the greatest difficulty. Enormous boulders of sandstone and conglomerate, among which grew a perfect tangle of vegetation, blocked the way, so that an hour and a half was spent in covering the entire distance of about three hundred and fifty yards in a straight line. The basin into which the water falls measures about two hundred yards in width by one hundred yards in length. As they approached the outer edge of this basin, the breeze was felt coming outwards, and the whole party were soon enveloped in mist and spray.

"At this point," says the traveller, "the Indian guide refused to go further, and then turned back. The sun cast its rays upon our backs, and produced small rainbows in front of our faces, which were most dazzling, and almost prevented our seeing the way in passing over deep fissures amongst the rocks. At the basin the mist and spray completely surrounded us, quite hiding the sun, like a dark cloud. Here we had to take shelter behind the rocks from the blinding storm of mist and rain which assailed us, driven outwards by the hurricane produced by the falling water, and through gaps witness the strange scene before us.

"The water in the basin most truly resembled a

huge boiling caldron, being lashed into great irregular waves, whose crests were blown into spray, and as they drove outwards in an irregular semicircle, were dashed against the rocks in front and the walls of the cave on either side, beating over one rock that I am sure was fifteen feet high. The foot of the descending column of water was rendered indistinct by the mist, but great fleecy masses of white foam spurted upwards many yards high, in clouds mixed with spray and mist.

"Standing there, I imagined that it exactly resembled a sea storm raging on a rock-bound lee coast. When I went in amongst the reeking wet rocks to the storm, I left the sun shining brightly, and the neighbouring forests unstirred by any wind whatever. Returning again, I came out of the mist into the sunlight, and by the time I reached the barometer station and looked back, I could hardly believe that such a disturbance in the water in the basin as I had witnessed still continued."

The cave above referred to lies behind the column of falling water, and is due to the excavating power of the liquid column as it rebounds from the basin. It is scooped out of the comparatively soft sandstone which lies underneath the hard conglomerate. This cave, therefore, corresponds both in position and in mode of formation to the "Cave of Winds"

at Niagara. Unlike the latter, however, the cave at Kaieteur is inaccessible, the precipices on either side of the fall being perpendicular at their foot, and washed by the water of the basin.

An interesting fact about this cavern is that thousands of swallows make it their home, issuing from it in the morning, and returning to it in large flocks at night. Late in the afternoon of the day that Mr. Brown and his party encamped near the fall, the swallows, he says, came in from all points of the compass in great flights, and gathering into two or three immense flocks, kept wheeling above us closely packed together. "I can only convey," he adds, "an idea of the multitude of these birds by saying that they were in myriads. Every now and then, as the flocks passed above the fall, thousands would swoop down almost perpendicularly with extraordinary velocity, and passing close over the edge, drop till opposite the great cave, then suddenly change their direction and shoot through the mist on either side into their roosting-places." He did not secure one of these birds, but from their size, as estimated by him, they are more likely to have been swifts than swallows.

Beautiful rainbows were noticed from time to time produced by the sun shining on the ever-ascending cloud of mist, these bows usually reach-

ing from the foot to half-way up the precipice. During the dry season the Potaro becomes very low, and the fall narrows considerably. At its lowest, however, according to the Indians, it still falls in one continuous column.

Fall of Tequendama.

AMONG the natural wonders of South America, the Fall of Tequendama ranks as one of the grandest. Through the lofty plateau of Bogota a river of the same name flows, and from the edge of this table-land its waters are precipitated into the plain beneath over a perpendicular rock about five hundred feet in height. A short distance above the fall, the river, which has already been greatly increased by the influx of tributaries, is one hundred and forty feet in breadth; it suddenly contracts, however, at the crevice into a narrow, deep bed, only forty feet across. Its strangled waters flow more rapidly, but are soon set free, as they bound in two leaps over the precipice into the abyss below—an abyss the depth of which has never yet been sounded.

According to an eye-witness, when this prodigious mass of water issues from the chasm above it forms an arch broad and brilliant in appearance; a little further down it resembles a white fleece; and

as it descends still lower it darts forth myriads of fanciful shapes more like fireworks than anything else to which he could compare them. Looking down from the level of the upper stream, it is impossible to see the base of the fall, so thick is the cloud of mist and spray that rises from it, and even its sides are only visible in the morning before the mid-day fog has invaded the landscape. If it thus hides somewhat the majesty of the fall, the mid-day mist forms, as it were, a vast white sheet whereon the sun's rays are for ever painting the most lovely rainbows, and the effect of which has been described as magical.

A recent French writer states that owing to the cooling effect of the perpetual drizzle of spray from the fall, the temperature at Tequendama is often as much as fifteen degrees Cent. lower than that of the city of Bogota, a few miles distant. However this may be, an English traveller—Captain Cochrane—who visited this celebrated fall in 1824, observed that while the plain above the fall was covered with grain and with trees of the temperate zone, nevertheless palms of the equinoctial valleys flourished at their foot.

The scenery heightens the effect. From the spot, says Captain Cochrane, "where the traveller pauses to observe this wonder of nature, the mountains



FALLS OF TEQUENDAMA, COLUMBIA.

rise in lofty majesty, covered with wood ; and birds of brilliant plumage peculiar to the place hover around and add to the enchantment of the scene. The loneliness of situation, the deafening roar of the waters, the luxuriance of the vegetation, the extent and magnificence of the scenery around, combine to render this one of the most picturesque and wildly romantic spots amid the whole range of the Cordilleras."

Most tempting to the botanist are many of the plants which grow on the sides of the fall within his sight, but for the most part beyond his reach. Upon a rock bathed by the cataract, says one collector, grows a curious plant—a *Podostemon*—specimens of which he had gathered amid the spray of the cataract. The *Gunnera scabra* displays its huge rough leaves in a fissure overlooking the abyss ; while a great begonia (*Begonia magnifica*) grows in the mist between the fragments of rocks disjointed by the bursting of the banks of the ancient Lake of Bogota, with beautiful scarlet flowers which make it the loveliest species of the genus.

The plain of Bogota is supposed to have been formerly a lake, and its present appearance somewhat justifies the belief. The Indians have a tradition explaining the disappearance of the lake and the origin of the fall. "In ancient days," they

say, "when the sun alone supplied light to the earth, and the people of Bogota were barbarians, an old man suddenly appeared amongst them from the East, with long garments and a white flowing beard. This was Bochica. He instructed them in agriculture, etc.; and with him came a woman, who, as well as himself, had three names, one of which was Chia. She was very beautiful, but very malevolent, and overturned everything Bochica attempted. By her magic she swelled the rivers and overflowed the plain, so that the people, with the exception of a few who escaped to the mountains, perished in the waters. Bochica, exasperated at her conduct, drove Chia from the earth, and she became the moon. He then, by the mighty force of his arm, broke a passage through the encircling Cordilleras, and constituted the Fall of Tequendama, by which means the lake formed by Chia was drained, and the plain of Bogota rendered more fertile and beautiful than it had been before."

The Fall of Tequendama was to the Indians a sacred place, where they were wont to offer sacrifices to commemorate that beneficent stroke of Bochica's wand by which a breach was opened in the rocks and his people saved from the flood.

Falls of Montmorency, Chaudière, and Lorette.

AFTER Niagara, the most interesting falls connected with the basin of the St. Lawrence are probably those of Montmorency, Chaudière, and Lorette, all situated within easy reach of Quebec.

The river Montmorency flows down from the northern mountains over a somewhat rugged bed until close to the St. Lawrence. Before losing its waters in that mightiest of Canadian rivers, its channel contracts to a width of about sixty feet, and it becomes surrounded with precipitous banks about two hundred and fifty feet high. Its waters then suddenly plunge over a sandstone precipice, falling in one unbroken sheet to a depth of two hundred and thirty feet.

It falls with a noise like thunder into a great basin, from which a cloud of vapour is ever rising into the air, and on which, as on a screen, the brilliant tints of the rainbow are painted by the

sunshine. In the dry season of summer the body of water rushing over the precipice is greatly reduced ; but in spring, after the rains, its volume is immense. The falls are beautifully situated, and never fail to produce a pleasing impression on the traveller.

One of America's best descriptive writers, Mr. W. D. Howells, thus describes them :—"The lofty bluff was scooped inward from the St. Lawrence in a vast irregular semicircle, with cavernous hollows, one within another, sinking far into its sides, and naked from foot to crest, or meagrely wooded here and there with evergreen. From the central brink of these gloomy purple chasms the foamy cataract launched itself, and like a cloud—

'Along the cliff to fall, and pause and fall did seem.'

I say a cloud, because I find it already said to my hand, as it were, in a pretty verse, and because I must needs liken Montmorency to something that is soft and light. Yet a cloud does not represent the glinting of the water in its downward swoop ; it is like some broad slope of sun-smitten snow. But snow is coldly white and opaque, and this has a creamy warmth in its luminous mass, and so there hangs the cataract unsaid as before. It is a mystery that anything so grand should be so lovely ; that



FALLS OF MONTMORENCY, CANADA.

anything so tenderly fair, in whatever aspect, should yet be so large that one glance fails to comprehend it all. The rugged wildness of the cliffs and hollows about it is softened by its gracious beauty, which half redeems the vulgarity of the timber merchant's uses in setting the river at work in his saw-mills, and choking its outlet into the St. Lawrence with rafts of timber and rubbish of slabs and shingles. Nay, rather, it is alone amidst these things, and the eye takes note of them by a separate effort."

Like Niagara, the Montmorency Fall is greatly altered by the frosts of winter; the surrounding vegetation becomes incrustated with ice, and the effect of the sun's rays shining on the frost-clad boughs is exceedingly brilliant. The spray, likewise, rising from the fall, freezes and forms two cones of solid ice which grow higher and higher as the frost continues.

The ice cones of Montmorency have been known to reach a height of one hundred and twenty feet, and they afford to the young people of Quebec—which is only eight miles distant—an excellent opportunity of indulging in the peculiarly American sport of "tobogganing." The *traineau*, or "toboggin," as it is called, is a sort of sledge which is dragged to the top of the cone, whence it descends with its rider at an astounding speed. One of the

cones, owing to its greater distance from the fall, is never so high as the other, and it is down the sides of this lesser eminence that the ladies chiefly disport themselves.

The great cone has at its base several chambers, used as refreshment rooms, cut into it, while its steep sides are ascended by means of steps cut in the ice. Arrived at the top, the visitor sees the fall behind him, its spray descending like little pellets all around. "Have a care," says a recent visitor to Montmorency; "go not too near the fall's side of the cone, lest you chance to slip over; if so, you would drop into the deep water at the foot of the fall and be carried under the ice no man knows whither. Some half-dozen unfortunates have, in fact, thus slipped and so disappeared for ever."

The same visitor has given the following vivid description of his first trip down the cone in a traineau:—"You are not in the habit of amusing yourself," he says, "by sliding down the roof of a house, and you feel that you are on the eve of going through an exaggerated performance of that nature. Did not honour forbid, you might prefer returning by the ignominious but safer route you have just mounted by. But that is out of the question; in another minute, quitting your scanty foothold, you will be launched into space. There is no help for it;



NATURAL STEPS AND RAPIDS OF THE MONTMORENCY, CANADA.



you must make the best of the inevitable. There is no time for hesitation—more sliders are arriving, and we must make room for others. ‘Now, sare; all ready, sare?’ inquired my red-capped guide. He is already seated on the front part of the traineau, his legs projecting on each side, his heels dug into the ice to prevent an untimely start. I seat myself behind him, curl my legs round his waist, and place my feet between his knees, take a firm hold of the stern end of the traineau, and commend myself to the care of Providence and my Canadian friend. He lifts his heels, a slight push is given us behind, and we are off!

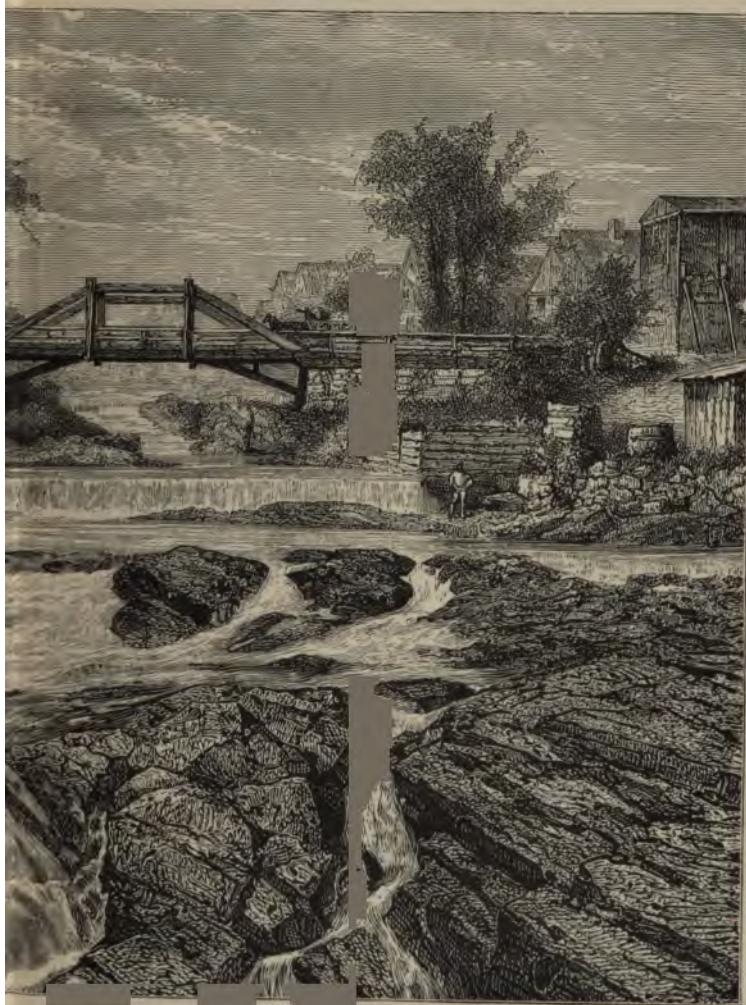
“Ha! ha! the traineau starts, and bounds clear into the air. I involuntarily tighten my hold. We fall some ten feet, and again touching the slippery surface, bound off again. Another drop, and we are on the more sloping sides of the cone; we fly down it breathless. In another instant we have reached the bottom; sharp icy splinters, ploughed up by the iron runners, hit us in the face and sting as shot would. But nothing stops us; we skim over the level at railway speed for some quarter of a mile or more, when, the acquired velocity exhausted, we roll off our quaint conveyance, shake the snow from our coats, and prepare to return.”

In spite of the break-neck appearance of this sport serious accidents seldom occur, although spills, attended with more or less discomfort, are common enough. The more adventurous of the Canadian "tobogganers" sometimes ascend with their traineaux up the precipitous cliff which, rising to a height of more than two hundred feet, bounds the left bank of the Montmorency below the fall. After climbing half-way up, they slide down with such terrific speed that the impetus thus obtained carries them right over the smaller cone and nearly to the summit of the larger one. Turning, they then glide down the side and bound far away over the plain.

Close to the fall, and commanding the finest view of it, is the Mansion House, a building of some historic interest. It was built by Governor Haldimand late in the last century, and was occupied from 1791 to 1794 by the Duke of Kent, the father of Queen Victoria. Half a mile above Montmorency Falls are situated the Natural Steps. Here the one bank of the river is a perpendicular wall of rock, while the other shows a series of huge steps, cut out as if by giants, with most remarkable regularity. The river at the Steps flows with great rapidity, and its waters are ceaselessly eating into the bank. It is no unusual sight, therefore, to see



FALLS OF LORE



16. NEAR QUEBEC.

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the trunks of trees uprooted from its sides being borne along to the falls by its rapid current.

Not far from Montmorency, near the banks of the river St. Charles, is the village of Lorette. In it resides the remnant of the once powerful tribe of the Hurons. Flying in terror from their relentless foes, the Iroquois, they left their ancient abodes in the west and settled here under French protection. The present inhabitants of Lorette are a quiet and sober people, in whom Indian blood predominates though it is never unmixed. Lorette has the further attraction of a cascade which, says Marshall, "would give fame and fortune to any spot in England or France." It is situated on the St. Charles, a river which, like all the others that have their source in the great forests of the North, has a never-ending flow of brown-coloured water. This, as it precipitates itself over a series of rocks into the plain beneath, breaks up into the most lovely cream-coloured foam.

About eight miles from Quebec, but on the southern bank of the St. Lawrence, is the cataract of Chaudière, or the "Caldron." According to M'Gregor, it is sufficiently interesting even for those who have beheld Niagara to visit. The Chaudière

River is a mighty torrent two hundred and forty yards in breadth, and at the fall it roars and foams in wild sublimity over immense ledges of rock of more than a hundred feet in height. It then rushes and boils and thunders over more rocks and ledges until within a short distance of its junction with the St. Lawrence.

The Chaudière, or Caldron, is also the name by which certain falls on the Ottawa are known. The rapids begin a few miles above the city of Ottawa; but as the latter is approached the channel contracts, and the rushing torrent, lashed into fury by obstructing rocks, plunges at one leap of sixty feet over a steep limestone cliff into the horse-shoe shaped basin known as the Caldron, where its seething waters whirl about in wildest confusion. They are thrown up in clouds of spray, which effectually conceal the bottom of the fall, and often rise in revolving columns high above the summit.

The existence of the Chaudière is made known to the traveller long before he sees it by its resounding noise striking on his ear; and long before reaching it, columns of mist, like jets of vapour thrown up by some gigantic machine, mark the locality of this famous Caldron. The quantity of water poured into this basin has been estimated by M. Tasse at four thousand five hundred cubic



THE CHAUDIÈRE FALLS IN SUMMER.

mètres per second during the season when the river is in flood. This is equal to the volume of the Rhine at Strassburg at its highest; and the Canadian river, owing to the numerous lakes in its course, which act as reservoirs and regulators, never falls away to the extent observable in such rivers as the Rhine. The huge volume of water thus thrown into the basin is believed to escape in part by subterranean channels.

The stolid Indians, even, seem to have been impressed by this cataract, for in former days they were in the habit of throwing a little tobacco into the Chaudière before commencing the land carriage of their canoes to the quiet waters above. The beauty of the falls has, however, been greatly impaired of recent years by the means adopted to utilize the immense water-power of the Chaudière. Some of the largest lumber works in Canada are situated on its banks, which are thus disfigured by the mountains of sawn wood that encumber them. Near to the falls are the timber slides by which the logs of wood from the upper river pass down without damage into the navigable water below.

Cataracts of the Orinoco and Parana.

WHEN Columbus was approaching the American coast, the enormous body of fresh water observed pouring into the sea convinced him that it must be a continent which so mighty a river drained. It was the Orinoco, the third largest of South American rivers, which, in its course of eighteen hundred miles, receives hundreds of tributaries, and at one point exhibits a phenomenon unique among rivers. At a considerable distance from its source the Orinoco bifurcates—one branch flowing onward as the main stream, the other striking southward until it joins the Rio Negro, a tributary of the Amazon.

Amid considerable stretches of navigable water there occur numerous obstructions in the form of cataracts and rapids that form a more or less insuperable barrier to the navigation of the Orinoco. The most important of these are the cataracts of Atures and Maypures, best known by the glowing descriptions of Humboldt, one of the first Europeans to visit them.

The Orinoco, after flowing about three hundred miles in a westerly direction, is joined by two important tributaries, each of them considerable rivers, and at their point of junction the united river suddenly flows northward. Here it encounters a chain of granitic mountains, in making its way through which the famous cataracts occur. These do not, like Niagara, consist of a single great fall, nor are they like so many of the cataracts of the Congo, due merely to a sudden narrowing of the river passage; but they result from the presence of an archipelago of islands in the stream, from blocks of granite piled upon one another, and from rocky dikes that form natural dams. Over these the water pours in small cascades that follow each other like the steps of a ladder.

The islands divide the river into a number of torrents, each of which boils up as it breaks against the rocks in its endeavour to find a passage. Sometimes the stream disappears, engulfed in some subterranean cavern; and Humboldt, standing in one of these, heard the water at once roll over his head and beneath his feet. In this instance the traveller had an opportunity of contemplating the strange scene, intensified by a storm, somewhat longer than he desired, owing to the delay of his Indian boatmen in returning to take him off. Some monkeys

he had with him in wicker cages, terrified by the tempest, raised plaintive cries, and attracted several large crocodiles to the spot. These creatures, he had been led to believe by the natives, did not frequent the neighbourhood of the cataracts, and on the strength of this assurance he had several times bathed in their waters. Another dangerous animal that frequents the cataracts is the jaguar, or American tiger. It is fond of deserted huts; and Humboldt, instead of seeking the shelter of these places at night, preferred camping out in the open air between two fires. He tells of an Indian, who, on returning to his hut near the cataracts, at the close of the rainy season, found it inhabited by a jaguar and her two cubs. They had occupied it for some months, and it was only after an obstinate fight that the fierce creature retired before the rightful owner.

Maypures and Atures are only about twelve leagues apart, and they are very similar in appearance. Each has its own specially difficult or dangerous ledges, minutely known to the Indian canoe-men. The "Leap of the Sardine"—the steepest of the ledges in the Maypures cataract—is about nine feet high, and forms by its breadth a magnificent cascade. The wild dashing of the waters and their continuous roar are, however, due less
fall—which, taken over the

whole series of ledges of Maypures, does not amount to more than thirty-two feet—than to the contraction of its bed by rocks and islands and to the multitude of its counter currents.

Gazing at the cataracts from a neighbouring height, “a foaming surface several miles in length, intersected with iron-black masses of rock projecting like battlemented ruins from the waters, is seen at one view. Every islet and every rock is adorned with luxuriant forest trees. A perpetual mist hovers over the watery mirror, and the summits of the lofty palms pierce through the clouds of vapoury spray. When the rays of the glowing evening sun are refracted in the humid atmosphere, an exquisite optical illusion is produced. Coloured bows appear, vanish, and reappear, while the ethereal picture dances, like an *ignis fatuus*, with every motion of the sportive breeze.”

The navigation of these cataracts is attended with considerable danger, even to the Indians, who are thoroughly acquainted with them. When the ledge is only two or three feet high the Indian does not hesitate to shoot the rapid in his canoe. In ascending the river the Indians swim in front of their frail barks, and if they can succeed in fixing a rope on any projecting rock that may crown the dike, they are able by this means to haul their canoes to

the top of the cascade. Not unfrequently, however, their boats are dashed to pieces against the rocks; and in this predicament the bruised and bleeding canoemen strain every nerve to escape the whirlpools, and to swim for the shore. Where the rocky ledges are too high for this method of ascent to be practicable, the canoes are hauled to land and conveyed on wooden rollers above the cataract.

Humboldt spent five days in the neighbourhood of these cataracts, and he was very much astonished to find that the noise of the roaring torrent was three times greater by night than by day. As the stillness of the virgin forest was as profound in the one season as the other, he attributes the difference to ascending currents of warm air in the day time obstructing the propagation of sound.

The Parana, with the other streams that go to form the river Plate, is, next to the Amazon, the greatest water-system in South America. In Brazil, where it rises, its navigation is impeded by rapids and by the cataract of Guayra, or Seven Falls, which is the greatest cataract in the Brazilian dominion. Immediately above the fall the river is two and a half miles wide. It is suddenly narrowed by passing through a line of seven islands which cross its channel, and its waters then rush down, not

a perpendicular precipice, but a slope inclined at an angle of 50° , and with a total height of about sixty feet, into a gorge only sixty-eight yards in breadth and enclosed between lofty cliffs. For the next thirty-three leagues the river rushes and tumbles along confined in its narrow bed, forming one of the most remarkable series of rapids in the world.

The roaring of the cataract of Guayrà is heard, and the columns of vapour that rise from its troubled waters are seen, for many miles around, while in the rays of the sun rainbows of the most brilliant hues are formed. The vapours fall all round in a continuous fine rain that soon wets any one approaching the falls, while the rocks in the vicinity seem to tremble beneath the feet.

The Hundred Cataracts, or Victoria Falls, of the Iguassu, near the junction of that river with the Paraná, have only been fully explored lately; but it would seem, from the description of a recent German exploring party, to be one of the grandest in the world. A few miles above it the river is three miles broad. It gradually narrows, however, until passing through an archipelago of little islands it pours by numerous channels over a horseshoe ledge of rock into a gorge nearly a hundred and fifty feet in depth, after which it flows for some distance through a narrow channel confined between lofty cliffs.

The falls of the Zambesi.

THE better knowledge of the interior of Africa obtained of late years has for ever dispelled the view that it is a burning desert, varied at long intervals with fertile oases. It has been shown to be a land of great rivers and mighty lakes, of snow-capped mountains and well-watered valleys.

No other continent can boast of four such rivers as the Nile, Congo, Niger, and Zambesi. They are among the longest of rivers, and by their vast network of tributaries they drain immense areas of land; while in three of them at least their onward course to the ocean is diversified by cataracts and rapids that count among the wonders of the world.

Of these the Victoria Falls, on the Zambesi, are the grandest in Africa, if not in the whole world. Niagara is generally regarded as the king of cataracts; but Charles Livingstone, brother of the famous traveller, and at least two other travellers among the very few who have seen both falls,

THE VICTORIA FALLS, ZAMBESI RIVER.



agree in regarding the Victoria Falls as surpassing those of Niagara in beauty. They are situated about a thousand miles from the mouth of the Zambesi, and the first European to see and describe them was Dr. Livingstone.

During his journeyings in the basin of that great river he had often heard of the falls, called by the natives Mosioatunya, or "smoke-sounding;" and he was frequently asked the question, "Have you smoke that sounds in your country?" In November 1855 he paid his first visit to the falls. The water at that time of year is low, so that they were not seen by him at their best. The lowness of the water, however, at that season enables the visitor, if under skilled guidance, to make his way to an island which forms part of the lip of the fall near its centre, and from which he can gaze down on the boiling waters below.

Moving down the river in a canoe, Dr. Livingstone first caught sight, at a distance of five or six miles, of those columns of vapour that for ever rise from the falls. They looked to him like the smoke rising from large tracts of burning grass. With care the canoe was safely guided through the rapids to the island, but even there he was at first unable to understand where the vast body of water went. It was only when he crept

to the edge and peered down that the mystery was solved.

The falls are due to an immense crack in the basalt rock which here forms the bed of the Zambesi—a crack extending right across the river. This cleft in the rock is only about eighty yards in width, and into this narrow chasm, more than one hundred feet in depth, the entire water of the mile-wide Zambesi is precipitated with deafening roar. A way of escape for the pent-up waters is found in a fissure on the opposite bank at right angles to that which forms the falls, and situated not far from their centre. To reach this narrow gateway the waters rush from opposite ends of the chasm and unite midway in a boiling caldron. After looking down for some time, says a recent traveller, into this raging, leaping, foaming, heaving chaos, deafened by the terrible noise of the maddened waters, and shaken by the menacing howl rising up continuously from the depths which seem to pierce through bone and marrow, one wonders that the rocks, those hard ribs of the earth, can withstand the shock of such a mighty onset.

The waters at last rush southward through this narrow but deep channel for a distance of one hundred and thirty yards, then pass into another fissure nearly parallel with that which constitutes

the falls. Through this they flow westward for some distance, when suddenly the river makes another bend in the opposite direction, only, however, to turn as abruptly again and to flow through another chasm westward. For some distance it describes this zigzag course, confined between perpendicular walls of rock five hundred or six hundred feet in height, and its channel only about two hundred and seventy feet wide. The water in this narrow, sinuous channel must be of immense depth, and this probably explains the smooth, gliding motion of its waters, "slipping round the points of the promontories with a resistless flow, unbroken save by a peculiar churning, eddying motion."

The falls were again visited by Livingstone in August 1860, this time in the company of his brother Charles, and in their joint work, "The Zambesi and its Tributaries," they give a more detailed account of the great "smoke-sounding" cataract. Again the river was low, which enabled them to attempt the passage down stream to the small island on the edge of the fall.

Even at such a time the voyage was by no means safe, and only one native, known as Tuba Makoro, or "smasher of canoes," knew the medicine which insured against shipwreck in the rapids. Under his guidance they made a sufficiently ex-

citing voyage. "At times," says Livingstone, "it seemed as if nothing could save us from dashing in our headlong race against the rocks which, now that the river was low, jutted out of the water; but just at the very nick of time Tuba passed the word to the steersman, and then with ready pole turned the canoe a little aside, and we glided swiftly past the threatened danger."

Once only did Tuba's medicine seem to fail. Planting the pole on a black rock which lay in the path of the canoe, and over which the white foam flew, in order to guide his craft past it, the pole slipped, the canoe struck hard on the rock, and in a moment was half full of water. Tuba, however, immediately recovered himself, shoved off the bow, and shot the canoe into still, shallow water.

They safely reached Garden Island, where five years before Dr. Livingstone had planted a garden of fruit trees—peaches and apricots and a quantity of coffee seeds; but he found that his labour had been thrown away, owing to the depredations of the hippopotami. These animals abound in the numerous islands, adorned with the richest vegetation, that dot the surface of the river above the falls.

From Garden Island the best view can be obtained of the fall, the chasm, and the promontory

opposite. To right and left the whole body of water is seen rolling clear over quite unbroken; but, says Livingstone, after a descent of ten or more feet the entire mass suddenly becomes like a huge sheet of driven snow. "Pieces of water leap off it in the form of comets with tails streaming behind, till the whole snowy sheet becomes myriads of rushing, leaping, aqueous comets."

The chasm itself is filled with a dense white cloud, on which the sun is ever painting double or treble rainbows. And from this cloud there rise those columns of smoke-like vapour, which in time of flood can, it is said, be seen ten miles off. The cause of this "smoke" is not far to seek: the water, breaking up into pearly drops as it descends into the abyss, carries with it a large amount of air, and this, being compressed into a narrow cleft, rebounds and rushes up in those eddying spray-clouds which have been described as gleaming like spectres far above the great altar of the waters.

Sometimes these vaporous columns are blended into one by an eastern breeze, and form a continuous curtain for the display of rainbow colours. A recent traveller thus describes the effect as witnessed by him from the grove facing the falls: "Think nothing," he says, "of the drizzling mist; but tell me if heart of man ever conceived any-

thing more gorgeous than those two lovely rainbows, so brilliant that the eye shrinks from looking at them; segments of which rise from the abyss deep as the solar rays can penetrate it, overarch spray, rock, and forest, till rising to the highest point they fail to find refractory moisture to complete the arch."

It is little wonder that the natives of this region, awed by the constant roar of waters, by these pillars of cloud that for ever rise from them, and by the many-coloured rainbows that preside over them, should have chosen the surrounding islands as places for offering sacrifice and prayers to their divinities.

The columns of spray, after rising to a height of two hundred to three hundred feet above the level of the river, condense and fall all round in a perpetual shower. On the promontory opposite this, fine rain is ever falling, and the dense grove of evergreen trees which clothe it are for ever dripping. This, says Livingstone, forms "sundry little rills which, in running down the steep face of the rock, are blown off and turned back, or licked off their perpendicular bed up into the columns from which they have just descended."

It is from this grove, only separated from the face of the falls by a space of about eighty yards,

that the best view of the cataract can be obtained. When the water is low, as it was during Livingstone's two visits, the river does not fall in one unbroken sheet along the whole mile of precipice which stretches across its bed. Facing the cataract, at the west end of the chasm, there is a fall thirty-six yards in breadth; a small island then intervenes; after which comes a great fall five hundred and seventy-three yards across, followed by another three hundred and twenty-five yards broad, from which it is only separated by a projecting rock. Garden Island next intervenes, and the remaining half-mile of fall is broken up into a series of small cataracts separated by wide intervals of bare rock. This, however, is only during the dry season, and during times of flood those to the east of Garden Island become united into one huge cataract.

Few travellers have seen the Victoria Falls when swollen with the rains of winter. The German traveller Mohr, however, visited them lately and saw them at their fullest. He heard the roar of the falling waters when he was still eight miles from them in a direct line. Approaching them from the south, he made his way along the tongue of land which faces the falls. This peninsula is covered with dense forest; its luxuriance being the

result of the constant rain which falls upon it from the clouds of spray. The cool shade and mud-baths to be had here make this rain-forest the favourite resort of buffaloes and elephants. Here, standing on a slab of rock, Mohr had a clear view of the front of the falls, and that under most favourable circumstances—the river being still swollen by recent rains. “The black rock masses were,” he says, “almost entirely hidden by the indescribably beautiful water draperies—the abrupt naked rock chasms only yawning here and there through the white veil of spray.” When he saw the cataract the first fall consisted of one long unbroken greenish blue wave, “which, as it sped on its further course, resolved itself into even finer, whiter, and more delicately rounded cloud forms.”

From the point on which he stood the grandest view of the “incomparable Victoria Falls of the Zambesi” is obtained. “Before us,” he says, “we have the full glory of the falling mass of water, ever moving, ever changing, blustering, foaming, glowing, shining,—with small green islands peeping over the very edge of the abyss; and on the left and right, above and below, water, water everywhere, hurrying onwards with a continuous roar like thunder. In front of the falls, where the water from the west and east meet and embrace, hang suspended

two double circular rainbows unbroken by any horizon, the magic hues glowing in the brilliant tropical sunbeams—blue, yellow, and red succeeding each other in the outer, and red, yellow, and blue in the inner ring.” When the traveller, lost for a time in wonder and admiration of the magnificent scene before him, turned to go, he found that he was wet through with the falling spray.

Making his way northward from the Cape diamond fields, Dr. Holub paid a visit of three days to the Victoria Falls in September 1878. The river Zambesi seems to have been comparatively low at the time; nevertheless, during the entire day before reaching his destination he heard the dull, heavy noise, like the rumbling of distant thunder, and saw the pillar of cloud that betokened his approach to the falls. Weary and footsore and faint with hunger, the traveller, after climbing a hill and scrambling through a thicket, suddenly found himself on the brink of the abyss into which the seething waters were rolling with a tremendous plunge. “The impression of that scene,” he says, “can never be effaced.”

At this point the traveller very nearly lost his life. Having had no food all day, and feeling faint with hunger, he laid hold of some fruit hanging down from a branch, and supposing that their thin

yellow shells covered a sweet fleshy pulp he greedily ate some. It suddenly flashed upon him, however, that the seeds had a strong resemblance to those of *nux vomica*, and the sickness with which he was almost immediately seized proved his guess to be correct. He was prostrated for some time, but a long draught of Zambesi water helped to revive him.

He spent three days exploring the neighbourhood of the falls, and he regarded them as the most satisfying and enjoyable part of his sojourn in South Africa. "At many cataracts," he says, "particularly at Niagara, our wonder is excited by the stupendous volume of the plunging water; at others by the altitude of the perpendicular rocks over which the torrent is precipitated; but here our amazement is aroused by the number of cascades and jets into which the down-rushing stream is divided, as well as by the narrowness of the deep ravine into which the raging waters are compressed."

Placing his reader beside him on a spot facing the falls, but about two hundred yards distant, he pictures the scene; and as his description differs considerably from those already given, owing, probably, to the lowness of the Zambesi at the time, we give it here:—

"About one hundred yards from the western bank he sees several islands adorned with tropical vegetation in rich abundance; further on towards the eastern shore, and close to the edge of the abyss, his eye will light upon nearly thirty bare brown crags that divide the rushing stream into as many different channels. To the left again, between the bright green islands and the western shore, he will observe that the great wall of rock is considerably lower, allowing a ponderous volume of water to rush impetuously as it were into a corner, whence it is precipitated in a broad sheet into the gulf below; beyond this and the next cascade he will see another portion of the surface of the rock, and as he carries his eye along he will be struck with admiration at the jutting peaks that stand out in vivid contrast to the angry foam that seethes between them. The countless jets and streams assume all colours and all forms: some are bright and gleaming, some dark and sombre; some are wide and some are narrow; but as they plunge impetuously into the depth below they make up a spectacle that cannot fail to excite a sensation of mingled astonishment and delight.

"Of the jets of water, some are so thin that they are dispersed before they reach the lower flood, and bound up again in vapour; others are from ten to

fifteen feet in breadth—these dash down with tremendous fury, their edges curled up and broken into angry foam and spray; the largest streams, especially those that pour along from the eastern shore, are caught by the jagged peaks and torn asunder, ending their career by rolling over and over into cascades. In the diversity of the forms the water takes, I believe that the beauty of the Victoria Falls is quite unparalleled."

The vegetation immediately above and below the falls he describes as of the most varied and luxuriant kind—sycamores and mimosas taller than the tallest poplars; creepers as thick as a man's arm climbing to the tree-tops, and affording a playground to the numerous apes that are to be seen at all times disporting themselves among the lofty foliage. The ground is an elastic carpet of moss bedecked with flowers and ferns—a flora due in large measure to the perpetual fall of spray from the cataract.

The spray at times ascends in columns that can be seen fifty miles away. It is so thick at times as completely to conceal the view, at others the wind thins it down to a more or less transparent veil. As the density of this veil increases or diminishes, "the islands that lie upon the farther side will seem alternately to recede or advance like

visions in a fairy scene." The spray from the falls gives out a hissing sound, which, however, can only be heard when a favouring breeze carries off the deafening roar of the cataract. The latter usually fills the air for miles around with a noise as of thunder; the ground beneath the feet trembles as if there were some convulsion in a subterranean cave beneath.

Dr. Holub explored the sides of the great zigzag ravine through which the Zambesi flows after its tremendous leap, and was struck with their endless diversity of form. At one place, for example, the banks were perpendicular, as though they had been cut by a mason's hand; at the next they sloped like the *glacis* of a gloomy rampart; while at another they assumed the appearance of a huge garden-wall richly clad with many-coloured vegetation.

In one of the numerous glens that run into this ravine Dr. Holub and his servant had an encounter with the baboons that frequent the region of the falls in great herds. Being anxious to obtain a skull of one of these, he fired and killed a baboon; but, unfortunately, it fell into the river and was lost. At his second shot he wounded two more. "This," he says, "induced the right wing of the herd to retreat; but the main body kept their ground, and the left flank, moreover, assumed the

aggressive, and commenced pelting us so vigorously with stones that, remembering that I had only one cartridge left, I considered it far more prudent to withdraw than to run the risk of a hand-to-hand encounter. Accordingly, we retired, most ignominiously defeated."

Major Serpa Pinto visited the falls in November 1878, and the impression produced on his mind by the sight was that of the "sublimely terrible." He regards the fall on the extreme west, which is the smallest of the three main divisions into which this mighty cataract is divided, as the most beautiful, or, "more correctly speaking, the only one that is really beautiful, for all else at Mozi-oa-Tunia is sublimely horrible. That enormous gulf—black as is the basalt which forms it, dark and dense as is the cloud which enwraps it—would have been chosen, if known in Biblical times, as an image of the infernal regions, a hell of water and darkness, more terrible, perhaps, than the hell of fire and light."

He attempted by means of triangulation to take accurate measurements of the height of the falls and the width and depth of the rift. To do this accurately it was necessary to see the foot of the wall; and to accomplish this he risked his life in what he himself afterwards regarded as a most foolhardy proceeding. He made his two native

servants strip off their garments, which he then tied together. These were made of striped cotton cloth that had already seen a good deal of wear. He bound the improvised rope about his body, under the armpits, in order to leave the hands free, and, sextant in hand, he ventured over the precipice. The loose ends were held by the two servants. "They trembled with fear," he says, "at the whole proceeding, and made me tremble in turn, so that it took me a much longer time than usual to measure the angle. When I told them to pull me up, and I found myself once more with the solid rock under my feet, it seemed as if I had just awoke out of a terrible nightmare."

The course of the Upper Zambesi is further broken by the Gonha Cataract, visited and described by Major Serpa Pinto in 1878. While still a day's journey from it, he heard a distant noise that reminded him of the sea breaking on a rocky shore. His boatmen confirmed his suspicion that they were nearing a cataract. The bed and sides of the river became more rocky, the current more rapid, and navigation dangerous.

After voyaging for five and a half hours without reaching the fall, they landed and pitched their camp beneath a gigantic sycamore close to the

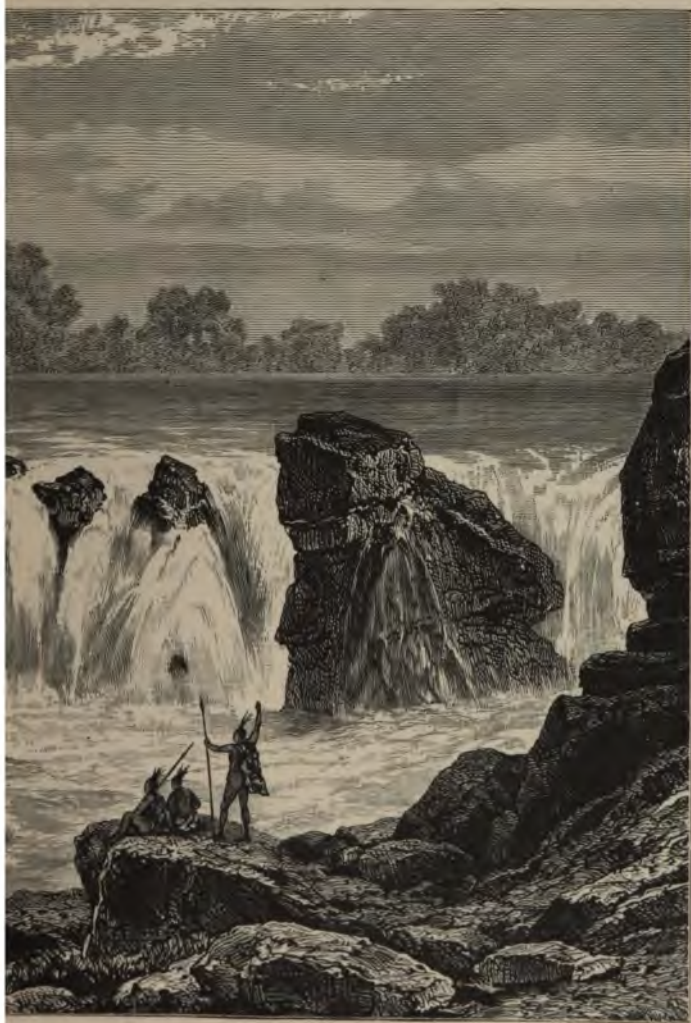
river-side. Here the traveller's sleep was disturbed by the roar of the still distant cataract; and early next morning he set off with a guide to visit it. He found that two other branches of the Zambesi joined it a little above the fall, and that the united river had then a width of about six hundred and fifty-six yards.

Its waters do not flow far until they encounter a transverse cutting of basalt, over which they are precipitated to a depth of about fifty feet with "a frightful roar." The water falls in three great masses, separated from each other by huge rocks, while between and over these innumerable lesser cascades tumble, producing a marvellous effect. On the north side of the river a portion of the volume of the Zambesi continues flowing for a short distance on the same level as the top of the cataract. At length, however, it pours itself into the main stream in five exquisitely beautiful cascades, the last of which is four hundred and forty yards below the great fall.

"The different points of view," says Pinto, "whence one can take in the entire space of the falls, render the scene more and more surprising; and never had I before beheld in the various countries I had visited a more completely beautiful spectacle. Gonha does not possess, perhaps,



THE GONHA



UPPER ZAMBESI.



the imposing character proper to great cataracts ; for all about it the landscape is soft, varied, and attractive. The forest vegetation is so mixed up and blended with the rock and water that the result is one harmonious whole,—as if the hand of a great artist had studied the aspect which each feature should assume.

“ Nor does the fall of the water into the vast abyss cause that deafening noise which is generally so painful ; the copious vegetation which surrounds it doubtless helps, when at a very short distance, to muffle the roar. No vapours arise from the depths to be converted into rain, and make a near approach so dank and disagreeable ; the falls allow of free access on every side, as if nature had taken a delight in allowing one of her loveliest works to be gazed upon at leisure. Gonha is like a magnificent casket which is visible to all who approach it, and which displays its exquisite workmanship for all the world to wonder at and admire.” Afterwards, when visiting the Victoria Falls, or Mozi-*oa-Tunia*, as he prefers to call them, he contrasts these with Gonha. In the latter, he says, everything is smiling and beautiful, while in the former everything is frowning and awful. Gonha, he adds, is beautiful as a balmy morning in spring ; Mozi-*oa-Tunia* is imposing as a tempestuous night in winter.



The Falls and Cataracts of the Nile.

THE Nile, the greatest of African rivers, and the greatest of all rivers in historical importance, has a course unbroken by falls or other bar to navigation during its long course through the valley of Egypt proper. From Assouan the great river is rendered more picturesque but much less navigable by a succession of cataracts and rapids that occur at intervals in the course of the six hundred miles between that station and Berber; while as its source is approached its waters leap over the Ripon and Murchison Falls—the latter entitled to be placed in the front rank of the world's cataracts.

The Nile, as Captain Speke discovered, has its cradle in the Victoria Nyanza; and its career as a river, issuing from the north end of that lake, is opened by its waters pouring over the Ripon Falls, so named by Speke after the president, in 1862, of the Royal Geographical Society. These falls, says their discoverer, were by far the most interesting

sight I had seen in Africa. Everybody ran to see them at once, though the march had been long and fatiguing. Though beautiful, the scene was not exactly what I had expected; for the broad surface of the lake was shut out from view by a spur of hill, and the falls, about twelve feet deep, and four hundred to five hundred feet broad, were broken by rocks. Still it was a sight that attracted one to it for hours: the roar of the waters; the thousands of passenger-fish leaping at the falls with all their might; the Wasoga and Waganda fishermen coming out in boats and taking post on all the rocks with rod and hook; hippopotami and crocodiles lying sleeping on the water; the ferry at work above the falls; and cattle driven down to drink at the margin of the lake,—made in all, with the pretty nature of the country, as interesting a picture as one could wish to see.”

Proceeding down-stream, the Nile for the next three hundred miles of its course is seen to have all the character of a mountain stream, rushing swiftly along, often confined between high cliffs, its course marked by numerous islets and frequent rapids. These at length culminate in the Murchison Falls, discovered by Sir Samuel Baker, and named by him in honour of the distinguished geologist, Sir R. Murchison. Baker had discovered

the great lake Albert Nyanza, and had reached that part of it where the Victoria Nile enters.

Speke had traced the Nile from the Victoria Nyanza to the Karuma Falls, about three-fourths of the way to the Albert Lake; and Baker promised him that he would explore thoroughly the doubtful portion of the river from Karuma to the lake which he had been forced to neglect. The river at the point from which Baker and his party started in their canoes was five hundred yards wide, and without perceptible current. After proceeding about ten miles, the river rapidly contracted to half its former width, the banks became steep, and the water exceedingly clear and deep.

The river gradually narrowed to one hundred and eighty yards, a current flowing westward towards the Albert Lake became distinctly perceptible, and when the paddles ceased working the roar of water could be heard. This proceeded, as his native guide stated, from a great waterfall now within a few miles of them. After rowing for a couple of hours they reached a few deserted fishing-huts, where the river made a bend, and where the din of the cataract drowned most other sounds. Here Baker met with the most extraordinary abundance of crocodiles. Every sand-bank on the river-side was covered with them, and on one of



MURCHISON FALLS, ON THE NILE.

these, twenty-seven were counted lying close together like logs of timber.

As soon as the canoes shot round the corner, Baker and his wife were rewarded by a magnificent sight. "On either side the river were beautifully-wooded cliffs rising abruptly to a height of about three hundred feet; rocks were jutting out from the intensely-green foliage; and rushing through a gap that cleft the rock exactly before us, the river, contracted from a grand stream, was pent up in a narrow gorge of scarcely fifty yards in width. Roaring furiously through the rock-bound pass, it plunged in one leap of about one hundred and twenty feet perpendicular into a dark abyss below. The fall of water was snow-white, which had a superb effect as it contrasted with the dark cliffs that walled the river, while the graceful palms of the tropics and wild plantains perfected the beauty of the view. This was the greatest waterfall of the Nile; and in honour of the distinguished President of the Royal Geographical Society I named it the Murchison Falls, as the most important object throughout the entire course of the river."

With the exception of the formidable Yarborah Rapids, about two hundred miles north of the Albert Nyanza, there is no serious impediment to

the navigation of the Nile until Berber is reached ; but from that place to Assouan, on the borders of Lower Egypt—a distance of eight hundred miles—rapids and cataracts follow at frequent intervals.

These cataracts of the Nile, when first seen, are distinctly disappointing : there is nothing about them to recall Niagara ; there is no deafening roar of water. The navigator has, however, his respect for them greatly increased after he has seen his boat pulled through them. The First Cataract—that at Assouan—has been thus graphically described by a recent American traveller : “ What we see immediately before us is a basin from a quarter to half a mile broad and two miles long ; a wide expanse of broken granite rocks and boulders strown haphazard, some of them showing the red of the syenite, and others black and polished, and shining in the sun ; a field of rocks, none of them high, fantastic in shape, and through this field the river breaks in a hundred twisting passages and chutes, all apparently small ; but the water in them is foaming and leaping and flashing white, and the air begins to be moved by the multitudinous roar of rapids.”

Boats pass both up and down these cataracts ; and the Nubians, both men and boys, swim the rapids with little risk, a few of them trusting

simply to their strength and agility, but most of them sitting astride on a log of wood, or clasping a bundle of canes or an inflated skin. It is one of the sights of the First Cataract to see these Nubians on their extemporized boats in the most dangerous of the rapids. The singular thing is, that to the spectator they seem to be sitting on the water. As they dash past, however, each is seen to be seated on a round log about five feet long. Some of them sit upright, with their legs on the log, displaying the soles of their feet, and keeping the equilibrium with their hands. They are popular ferry-boats these logs on the Upper Nile, and women have been seen crossing the river upon them, their clothes in a basket, and the basket on their head.

It is not a passage to be lightly attempted by other than natives accustomed to the water, and many Europeans have lost their lives in making the attempt. The Nubian pilots are very dexterous in guiding the boats both up and down stream, and this work is consequently left entirely in their hands.

The traveller above referred to had a boat one hundred and twenty feet in length, and a cabin in it "as large as a hotel," taken up the First Cataract. The boat was unusually long, and the cataract people themselves showed unusual interest in the passage. To the traveller there seemed half a

dozen channels all equally uninviting; the one chosen had an awkward bend in it. Slowly they draw in, the boat trembling at the entrance of the swift water; the current seems too strong for it; it hesitates. At this critical instant, while every one holds his breath, a naked man appears on the bow with a rope in his teeth; he plunges in and makes for the nearest rock. He swims hand over hand, swinging his arms from the shoulder out of water and striking them forward, splashing along like a side-wheeler—the common way of swimming in the heavy water of the Nile. Two other black figures follow him, and the rope is made fast to the point of the rock, and there is thus something to hold them against the stream.

The greatest activity and noise now prevail on board, one gang of Nubians hauling on the rope to draw the great sail close to its work, another gang hauling on the rope attached to the rock, while all sing that wild chanting chorus, “without which no Egyptian sailor pulls an ounce or lifts a pound.” More men now appear on the rocks, and these laying hold of the rope lend their aid. Even with this the boat still trembles in the jaw of the pass; the stern is seen to graze the sharp rocks; but just in the nick of time the bow swings round, and the first danger is over.

There are many others ahead, however, to get over which the same methods are applied, with plenty of shouting, of rope-pulling, and even of dashing into the water; for at some points a row of men in the water are to be seen on one side of the boat, heaving at her with their broad backs to prevent her smashing on the rocks. The last struggle is the most difficult of all. It is up the main cataract. In addition to the numerous ropes, a cable is here attached and carried out over the rocks. The water here sucks down from both sides through a channel perhaps one hundred feet wide, very rapid from its considerable fall, and with such force as to raise a ridge in the middle. "To pull up this hill of water is the tug: if the ropes let go, we shall be dashed into a hundred pieces on the rocks below, and be swallowed in the whirlpool." The ropes, however, do not give way; and pulled at by several hundreds of stalwart Nubians, who never for a moment suffer the boat to get an inch the advantage, it slowly creeps on until a point is reached where a favouring breeze catches the sail, and the wind has an easy victory over the current. Smooth water is soon gained, and the First Cataract has been ascended in the marvelously short period of four hours.

The passage of the last of the cataracts

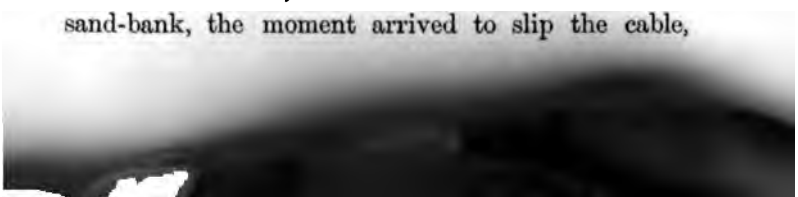
Nile—that between Berber and Khartoum—very nearly terminated Sir Samuel Baker's journey down the Nile. He was surprised to see the Nile suddenly contracted to a width of from eighty to one hundred and twenty yards. "Walled in," he says, "by high cliffs of basalt upon either side, the vast volume of the Nile flows grandly through this romantic pass, the water boiling up in curling eddies, showing that rocky obstructions exist in its profound depths below.

"Our voyage was very nearly terminated at the passage of the cataracts. Many skeletons of wrecked vessels lay upon the rocks in various places. As we were flying along in full sail before a heavy gale of wind, descending a cataract, we struck upon a sand-bank—fortunately not upon a rock, or we should have gone to pieces like a glass bottle. The tremendous force of the stream—running at the rate of about ten or twelve miles per hour—immediately drove the vessel broadside upon the bank. About sixty yards below us was a ridge of rocks, upon which it appeared certain that we must be driven should we quit the bank upon which we were stranded. The reis and crew, as usual in such cases, lost their heads. I emptied a large waterproof portmanteau, and tied it together with ropes, so as to form a life-buoy for my wife and

Richarn, neither of whom could swim; the maps, journals, and observations I packed in an iron box, which I fastened with a tow-line to the port-manteau. It appeared that we were to wind up the expedition with shipwreck, and thus lose my entire collection of hunting spoils. Having completed the preparations for escape, I took command of the vessel and silenced the chattering crew.

“ My first order was to lay out an anchor upstream. This was done: the water was shallow, and the great weight of the anchor, carried on the shoulders of two men, enabled them to resist the current, and to wade hip-deep about forty yards up the stream upon the sand-bank.

“ Thus secured, I ordered the crew to haul upon the cable. The great force of the current bearing upon the broadside of the vessel, while her head was anchored up-stream, bore her gradually round. All hands were now employed in clearing away the sand and deepening a passage: loosening the sand with their hands and feet, the powerful rapids carried it away. For five hours we remained in this position, the boat cracking, and half filled with water; however, we stopped the leak caused by the strain upon her timbers, and having, after much labour, cleared a channel in the narrow sand-bank, the moment arrived to slip the cable,



hoist the sail, and trust to the heavy gale of wind from the west to clear the rocks that lay within a few yards of us to the north. 'Let go!' and all being prepared, the sail was loosened; and filling in the strong gale with a loud report, the head of the vessel swung round with the force of wind and stream. Away we flew! For an instant we grated on some hard substance; we stood upon the deck watching the rocks exactly before us, with the rapids roaring loudly around our boat as she rushed upon what looked like certain destruction. Another moment, and we passed within a few inches of the rocks within the boiling surf. Hurrah! we are all right. We swept by the danger, and flew along the rapids, hurrying towards old England."

In the Soudan expedition for the relief of General Gordon it was intended to convey the troops up the Nile by boat all the way to Khartoum. Although circumstances prevented this plan being adhered to in its entirety, the troops were so conveyed as far as Korti, fourteen hundred miles from the sea, while a column under General Earle continued the river-journey, until the news of Gordon's death brought the expedition to a close. Eight hundred whale-boats, manned partly by Canadian boatmen accustomed to navigate the rapids of the St. Lawrence, took part in the ex-

pedition. These boats were conveyed by railway past the First Cataract, after which they were launched on the Nile. They made their way to Korti occasionally through miles of rapids, over which they were tracked, poled, rowed, sailed, and portaged according to circumstances.

The most interesting and exciting event in connection with the Nile expedition, so far as the cataracts were concerned, was the passage of the second of these—the great cataracts—by the armed steamer *Nassif-Kheir* in September, and the following account of which is condensed from that given by the *Times* correspondent. All the cataracts to within a day's march of Dongola had been surveyed in May, and were pronounced to be passable for steamers of five feet draught at high Nile—about the middle of August. The gear necessary, however, for the operation did not arrive till the beginning of September, by which time the Nile had begun to fall, the flood of that year not having been particularly favourable. No time was lost in beginning operations; blocks and hawsers were fixed on every convenient rock. Gear of all kinds likely to be necessary was stored on board the steamer, while a wire cable was fitted round its sides.

The *Nassif-Kheir* started on her perilous journey on the morning of September 3rd. As a mea-

sure of precaution, men who could not swim had been turned out of the vessel; and in view of possibilities, a plentiful supply of inflated skins was stowed on deck ready for immediate use. There were five thousand men on shore, comprising the Naval Brigade and an army of Esneh and Dongola labourers, all of whom were awaiting the arrival of the steamer just below the first gate of the cataract between the east bank and an island of some size. The Esneh men, clothed in blue, the Dongolese black as jet, and scarcely clothed at all, interspersed with little bands of English sailors, whose broad shoulders contrasted with those of the slightly-built Nubians, formed a highly picturesque scene. Among the natives fifty grave-looking Bashi-bazouks were to be seen stalking about, whose duty it was to see that the natives did their work; for these Nubians would only work when driven to it by the dreaded kourbash with which each Bashi-bazouk was armed.

On the arrival of the steamer, the chief of the Bashi-bazouks gave the order, and the swimming portion of the native host were driven to the water's edge, where each man, after deftly binding his garment round his head and inflating his water-skin, which is the travelling carriage of every Nubian Nile-dweller, swam across to the island.

"In a few moments," says the writer, "the surface of the river was dotted with innumerable little bobbing figures, some being borne down-stream at tremendous pace by a race more than usually swift, some stationary in a stretch of back water, some spinning top-like round and round in an eddy, from which it was not easy to escape, and all laughing and shouting or *coeying* to each other with a peculiar and not unmusical double note by which these river-dwellers convey their voices to a great distance above the rush of the wind and the roar of the stream."

During the first day they tracked the steamer over the first two gates, where the channel was so narrow that never at any time was she clear of the rocks on both sides. The greatest cause of danger was the use of grass hawsers instead of hemp; but the necessity that they should float rendered the employment of grass ropes imperative. Their weakness, however, more than once proved well-nigh fatal to the steamer; thus, two five-and-a-half-inch grass hawsers parted simultaneously just as the steamer had reached the top of the second gate. The moment was critical: behind her was a drop of a foot and a half, over which some million tons of water were pouring angrily, and below this was a sharp turn in the stream.

Luckily, instead of being carried down the falls, as might have been expected, the steamer swung into the shore, where she was easily held until the arrival of fresh hawsers. By means of these she was safely tracked to a quiet place above the second gate, and the first day's labour was over. The Nubians took to their water-skins and floated gaily down to their encampment for the night. There still remained four gates to pass—the last, or Great Gate, the worst of all.

Next day, the authorities found to their consternation that the water in the rapids had fallen during the night two or three feet, and further progress seemed impossible. This fall, it was thought, might be temporary; but three days of waiting only made matters worse, the river falling steadily three or four inches every twelve hours. Things were seemingly hopeless, when the sheik, who had come from Dongola specially to pilot the steamer, was at length got to say that he considered a particular channel practicable; and to prove that his estimate of the depth was correct, he jumped into the flood, where, after reaching the most dangerous part of the race, he threw up his arms and for a time disappeared.

Two days later the attempt was made and proved successful, although there was considerable

damage done, especially to the steamer's paddles, and she had some hairbreadth escapes from destruction. At one time, when in a most dangerous position, three of her four hawsers broke; a boat which put off to carry a cable to her had got almost within reach when she went to pieces on a sunken rock, and the crew were with the utmost difficulty saved by those on board the steamer. The cable, however, was secured, and the *Nassif-Kheir*, with her port-paddle smashed, was got over the gate.


Two days after, on her way to the Great Gate, three British sailors lost their lives. Some eight sailors and a party of natives were tracking the ship's boat up-stream to the steamer. Two men were in the boat, the rest on the shore. The natives on the bank being unaccompanied by any one who knew their language, thought the opportunity a good one for shirking their work. Accordingly they twice slackened the stern-painter so suddenly as to swing the boat out into the stream, bringing her broadside on to the current. Again it was done; but this time the gunwale being low, the boat filled, and the force of the current washed one of the men into the water, while the other jumped after him. On this three of their comrades rushed into the stream to their assistance; but so strong

was the current that one of them was immediately carried out into the race, and disappeared with the two occupants of the boat. The bodies of all three were afterwards found, and interred near the scene of the accident.

The Bab-el-Kebir, or Great Gate of the cataract, is a narrow passage some fifty yards long and thirty-four feet across at its widest part. On either side are high rocks, between which the water boils and surges down an incline of one foot in ten, ending with an actual fall of about five feet. In a passage like this the steamer's paddles could be of no possible use, and so were removed. Here it was necessary to trust entirely to the wire cable round the steamer, to the eight-inch hempen hawsers which were to track her, and to the goodwill and energy of the three thousand natives who were to do the actual work of hauling. The natives worked right lustily; and a couple of hours' steady hauling brought the steamer to the top of the channel and into calm water. Then, says the correspondent, "a mighty shout arose from the native labourers, who clapped their hands, danced, flung themselves on to the ground, jumped into the water and paddled round the steamer, and performed a thousand absurd antics indicative of the exuberance of their joy."

The Falls of the Senegal.

PASSING through the Desert of Sahara so as to emerge from it by its south-western extremity, the traveller would come upon the river Senegal. It is about a thousand miles in length, but its navigation, like that of all the other West African rivers, is interrupted at several points by rapids and waterfalls. The chief of these are the Felou and Govina Falls. Some years ago Mr. A. W. Mitchinson sailed up the river Senegal beyond both falls. After passing the village of Medina, about 500 miles from the sea, navigation became impracticable, the bed of the stream being filled with boulders, over which the boats had to be hauled. This brought his party to the Fall of Felou, where the river, compressed between narrow cliffs, rushes roaring and foaming with great force over rocky obstructions in the channel that form an almost perpendicular wall. Here goods and boats had to be carried over the rock and launched in the upper basin.



There are traditions among the natives that a great lake existed on the plateau above the fall, but that long ago it burst through at the rock of Felou, and that its waters made their way to the west coast. The sandy plains of the upper plateau form, according to this theory, the dry bottom of this ancient sea—a tradition agreeing well with the view that the Sahara Desert was formerly covered by the ocean. This would also explain the fact that the rock of Felou is worn, polished, and fantastically grooved far above the water-mark now made by the Senegal, showing that it was at one time subjected to the erosive action of water at a much higher level than it is now.

Once afloat above the cataract, the river widened, and suddenly expanded into a lake three miles in width. The light strongly refracted on its surface produced a mirage in which birds were seen floating like spectres in an expanse of water from horizon to horizon. Arrived at the village of Dinguira, Mitchinson found that two white men who had lately visited the place, and had thereafter proceeded downstream to Felou rock, had gone with their boat over the waterfall, and that one of them had been drowned.

Between this village and the Fall of Govina the river became unnavigable by reason of a succession

of small rapids. The traveller accordingly made his way to the fall on foot. The country around it he found destitute of both animal and vegetable life, with the exception of a solitary tree close to the waterfall, where marks of pilgrims' camping-fires were visible. There he and his party, exhausted with their day's journey, lay down and slept amid the deep roaring of the fall and the heavy long snores of the hippopotami in the basin. The Fall of Govina has a breadth of over five hundred yards when the water is low ; it has probably twice the breadth at flood time. Here the river suddenly precipitates its foaming waters in a mass to a depth of sixty yards. M. Mage visited Govina in 1863, and saw it in flood. It then presented, he says, an admirable spectacle, falling in sheets, interrupted by immense blocks of rock so worn and pierced by the waters that the latter made their escape in a thousand elegant rills, and greatly added to the picturesqueness of the scene.

Pushing further up the Senegal than Mitchinson had done, M. Mage encountered another fall, in connection with which he relates an interesting story of the hippopotamus—a creature of which he saw more in this journey than in the course of all his other African wanderings. When he and his companions had hoisted their canoe into the basin



above the fall, which at this place was not very deep, they were surprised by the very curious spectacle of a herd of hippopotami up to the middle in the water, that being all its depth. The old ones immediately precipitated themselves into the deep water beyond ; but a young one, seeking to follow its mother, put itself within range of the traveller's revolver, and he lodged three balls in its head. Although its blood flowed, it succeeded in reaching its mother ; but getting soon exhausted, it quitted her side, and was drawn by the current into the rapids. " I shall never forget," he says, " what followed. The mother, by an incredible effort, raised half of her body out of the water, and seeing her little one carried down by the flood, she rushed after it with amazing speed, but only arrived at the edge of the precipice in time to roll over with it into the abyss below."



FALL ON THE SENEGAL, WEST AFRICA.

The Cataracts and Rapids of the Congo.

TEN years ago the course of the Congo was a mystery. For centuries its mouth on the Atlantic seaboard had been known to Europeans, and they had even penetrated some little distance up its stream. But the region in which it took its rise, the direction in which it flowed, the extent of country it drained, were wrapped in impenetrable mystery. That it must be one of the greatest rivers of the globe was evident; for it was seen to flow into the ocean by a channel ten miles wide and thirteen hundred feet deep, and a little calculation showed that it bore two million cubic feet of water every second into the Atlantic—a flood only second to that of the Amazon.


It was left to Stanley, the heroic discoverer of Livingstone, to trace this giant river from its source in the Lake Region of Central Africa to its junction with the sea on the west coast. For eight months the American explorer and his party made

their way down the river amid dangers and hardships probably never surpassed in the annals of African exploration. In this toilsome march he lost a large number of his followers by war, pestilence, and accident, and at the close it left him a prematurely gray-haired man.

The dangers and adventures of this river journey Stanley has vividly described in his work, "Through the Dark Continent," and many of the most thrilling and tragic of these arose from the numerous rapids and cataracts that marred the course of this otherwise noble river.

The party embarked on the great river on 28th December 1876, Stanley's boat, the *Lady Alice*, leading the way, and nine days thereafter the first cataract of the Stanley Fall series was reached. The river, which had been two thousand five hundred yards wide, began to contract, and soon was heard the roar of the rapids. To make matters worse, the shores were lined with hostile and ferocious savages, and Stanley saw himself face to face with death either by drowning in the turbulent waters or by the knives of cannibals.

He chose to fight for life with the latter, and so ran his little armada ashore. The muskets—forty-eight in all—of his followers carried the day, and they bore in triumph their boats overland past the



first cataract, and were once again afloat on calm water. Not for long, however, as next day they were again within sound of another fall. Over this they pushed a rotten and condemned canoe, in order to note the result. After shooting down like an arrow, it circled round the whirlpool for an instant, and was then sucked below, emerging, however, shortly afterwards thirty yards away. Passage by water was thus evidently impossible, and again landing they succeeded, after seventy-eight hours of terrific exertion, in reaching the river, and in once more launching their canoes.

These had now to float down a two-mile stretch of rapids, and this was at length accomplished, although not without loss of life. One of the canoes capsized, and two of its three occupants succeeded in swimming ashore; the third clung to the boat, and was carried to the very brink of the fall. Here the canoe struck upon a rock that projected a little above the water, and one side getting jammed below, the other was tilted up. To this the half-drowned man clung, his ankles washed by the rushing water.

Two of the party volunteered to go in a canoe to his rescue. Stout cables were attached to bow and stern, and the boat drifted towards the edge of the precipice. When within ten yards of their man, they threw him a cable, and with it in his hand he

disappeared over the chasm. The canoe drifted against a rocky islet, and its two occupants, leaping on *terra firma*, hauled their friend from out the seething waters. All three were now in need of rescue, situated as they were on an islet with fifty yards of wild waves and a resistless rush of water between them and the shore. There, nevertheless, they had to remain overnight, but next morning, by means of cables thrown to them, they were safely landed.

The Congo at this point is considerably broken up by islands, which divide the stream into numerous channels. Where these channels reunite, Stanley found their united waters "tumble into one huge, boiling, heaving caldron, wherein mounds of water are sometimes lifted upward, and are hurled down several feet with tremendous uproar." To avoid this to him one of the wildest water scenes conceivable, a road three miles in length had to be cut.

After several days' sailing they arrived, on January 23rd, at the sixth cataract, which is formed by a broad dike of shale crossing the stream. Impassable towards the left bank, it was found to consist of a series of shallow rapids on the right, and down these Stanley succeeded in conveying his expedition without loss of life or serious accident.

Four days later the roar of the seventh and last



STANLEY IN THE RAPIDS OF THE CONGO.

cataract of the Stanley Falls burst upon their ears with a tremendous crash. The river, which a mile above the fall is thirteen hundred yards wide, is here contracted to a width of five hundred yards. "As it becomes narrower," says Stanley, "the current quickens, and rushes with resistless speed for a few hundred yards, and then falls about ten feet into a boiling and tumultuous gulf, wherein are lines of brown waves six feet high leaping with terrific bounds, and hurling themselves against each other in dreadful fury.

"Until I realized the extent of the volume that was here precipitated, I could hardly believe that it was indeed a vast river that was passing before me through this narrowed channel. I have seen many waterfalls during my travels in various parts of the world, but here was a stupendous river flung in volume over a waterfall only five hundred yards across. The river at the last cataract of the Stanley Falls does not merely fall; it is precipitated downwards. The Ripon Falls at the Victoria Lake outlet, compared with this swift descent and furious onrush, were languid. The Victoria Nile, as it swept down the steep declivity of its bed towards Unyoro, is very pretty, picturesque, even a sufficiently exciting scene; but the Livingstone (Congo), with over ten times the volume of the Victoria Nile,

though only occupying the same breadth of bed, conveys to the sense the character of irresistible force, and unites great depth with a tumultuous rush."

A numerous population inhabits the islands and both banks of the Congo in the neighbourhood of the seventh cataract, and they utilize this barrier to navigation as a fishing station. Taking advantage of the rocks to a distance of about a hundred yards on each side of the fall, they fix heavy upright poles, to each of which they attach enormous fish-baskets, made of ratan-cane cables. Probably sixty or seventy of these baskets are thus placed daily on each side of the river; and judging from the half-dozen baskets taken up by Stanley's men, which were found to contain twenty-eight large fish, one of them weighing seventeen pounds, the fishing would seem to be fairly successful.

After twenty-one days of constant toil and danger they were at last at the end of the Stanley Falls, and their troubles, so far as the river was concerned, ceased for some time. They now floated on the bosom of a magnificent river, which spread out to a breadth of a mile or a mile and a half, and whose lofty banks were covered with forest "impenetrable to star or sunlight." The natives, however, on both banks were hostile as ever, and the

expedition had to fight almost every inch of its way.

For six weeks they sailed onward, the Congo ever growing larger by the inflow of huge tributaries, until they reached the western verge of the great central table-land, about four hundred miles from the Atlantic. They were still eleven hundred and fifty feet above the level of the sea, and it was not long till they discovered that the descent included another series of cataracts more numerous and formidable than those of Stanley Falls. These, occurring at intervals during the next two hundred miles, and numbering in all about thirty cataracts, Stanley named the Livingstone Falls.

The smooth water terminated in Stanley Pool, where the river expanded from fourteen hundred yards to two thousand five hundred yards in breadth. As they entered the pool, islands rose in front of them like a sea-beach, and on the right towered a long row of cliffs, white and glistening, so like the cliffs of Dover that Frank Pocock, the only remaining white companion of Stanley's, at once exclaimed that it was a bit of England. With this splendid sheet of water the easy navigation that had lasted for weeks came to an end, and Stanley entered upon the severest hardships and trials of his river voyage.

Happily there was a change in the disposition of the natives. They had had previous experience of European traders from the west coast, and were accordingly disposed to be friendly. "It is the dread river itself," says Stanley, "of which we shall have now to complain. It is no longer the stately stream whose mystic beauty, noble grandeur, and gentle uninterrupted flow along a course of nearly nine hundred miles, ever fascinated us, despite the savagery of its peopled shores; but a furious river rushing down a steep bed obstructed by reefs of lava, projected barriers of rock, lines of immense boulders, winding in crooked course through deep chasms, and dropping down over terraces in a long series of falls, cataracts, and rapids. Our frequent contests with the savages culminated in tragic struggles with the mighty river as it rushed and roared through the deep, yawning pass that leads from the broad table-land down to the Atlantic Ocean."

Four days after reaching Stanley Pool the three cataracts at Ntamo were encountered. They were known among the natives as the "Child," the "Mother," and the "Father." The first and second were passed without much difficulty. The "Father," however, was the wildest sheet of water Stanley had ever seen. "Take a strip," he says, "of sea blown

over by a hurricane, four miles in length and half a mile in breadth, and a pretty accurate conception of its leaping waves may be obtained. Some of the troughs were one hundred yards in length, and from one to the other the mad river plunged. There was first a rush down into the bottom of an immense trough, and then, by its sheer force, the enormous volume would lift itself upward steeply, until, gathering itself into a ridge, it suddenly hurled itself twenty or thirty feet straight upward, before rolling down into another trough. If I looked up or down along this angry scene every interval of fifty or a hundred yards of it was marked by wave-towers—their collapse into foam or spray—the mad clash of watery hills, bounding mounds and heaving billows, while the base of either bank, consisting of a long line of piled boulders of massive size, was buried in the tumultuous surf. The roar was tremendous and deafening. I can only compare it to the thunder of an express train through a rock tunnel. To speak to my neighbour I had to bawl in his ear.

“The most powerful ocean-steamer going at full speed on this portion of the river would be as helpless as a cockle-boat. I attempted three times, by watching some tree floated down from above, to ascertain the rate of the wild current by observing

the time it occupied in passing between two given points, from which I estimate it to be about thirty miles an hour."

The canoes had to be transported by land past the "Father," and as another cataract was not far distant, Stanley gave orders that the canoes should hug the shore, on no account venturing into mid stream for fear of the current. Unfortunately in the case of one canoe this order was disregarded, with fatal results. When the others had reached in safety the camping-place for the night, which was immediately above the next cataract, Stanley to his horror saw one of his finest canoes, manned by five of his favourite followers, in mid river, gliding with the speed of an arrow towards the falls. Nothing could be done either in or out of the canoe to arrest its progress, and down the cataract it shot. Three or four times was it whirled round, and then it plunged into the depths, out of which the stern emerged for a moment pointed upwards, when all was over with its hapless crew.

While the traveller was bewailing his loss, another canoe with two men appeared, and it likewise went over the cataract; but in this case, by great good luck, the canoe righted itself after the plunge, and the men succeeded in landing a mile further down, but on the opposite bank of the river. A third

canoe containing the lad Soudi next darted past, and the boy, crying out, "There is but one God. I am lost, master!" went over, and was given up for lost; but next day he came into the camp, having made a miraculous escape from the whirling waters.

A fortnight later the *Lady Alice*, with Stanley on board, passed through the Lady Alice Rapids. It was intended, by means of strong cables, to let the boat gently down the rapids, but through carelessness on the part of some of the crew the current was allowed to sweep the boat from their hands, and away it darted into the centre of the foaming billowy stream. The tumult of the waters drowned all other sounds, and the boat went swinging along, at one moment almost engulfed in the trough of the waves, at another tossed on their crest, while occasionally it was whirled round like a spinning-top.

Death seemed every moment inevitable, and never more so than when they came abreast of the spot where it had been intended to encamp. Here, with a noise like thunder, the water was heaved up as by a subterranean volcano, and to the summit of this watery mound they were impelled. By a frantic use of the oars the *Lady Alice* was driven to the lower side of the mound, and before the waters had time to draw her into their whirl, she shot down a small fall, and was safe.

They landed in Nkenké Bay, and encamped in sight of four cataracts. One of these was produced by a river, which Stanley named Cataract River, leaping over a steep cliff into the Congo four hundred feet below. Another was the Nkenké, which, in haste to join the great river, rushes down steeply like an enormous cascade from the height of a thousand feet. The noise of the latter resembled the roar of an express train over an iron bridge, that of the former like the rumble of distant thunder.

Ten days more brought them to the next river barrier, the Inkisi Falls, which they reached on April 21st, having during the previous thirty-seven days of toil and danger only progressed thirty-four miles. The Inkisi Falls, like most of those on the Congo, have no clear drop, but are caused mainly by the sudden narrowing of the channel and the commotion of the half-strangled waters. Here the river, forced through a chasm only five hundred yards wide, "is flanked by curling waves of destructive fury, which meet in the centre, overlap and strike each other, while below is an absolute chaos of mad waters, leaping waves, deep troughs, contending watery ridges, tumbling and tossing for a distance of two miles."

To shoot those falls and live was impossible, so a road had to be formed up the hill-side to the table-

land twelve hundred feet above the river, and over this the canoes were transported. Other falls appeared in quick succession, and in attempting to pass one of these—the Massassa—Frank Pocock, the last of Stanley's white men, lost his life.

The leader had gone ahead to make friends with the natives at the spot chosen for their next encampment. Pocock, who was suffering from ulcers in his feet, was to have been carried overland. The helplessness which this implied was distasteful in the last degree to one of his self-helpful disposition, and in spite of the declarations of the boatmen, who regarded the Massassa Fall as impassable, he induced them to make with him the attempt. This they did, and on reaching the fall they plunged headlong amid the waves and spray. Their canoe was dragged down into the abyss, and the waters closed over them.

In a little while the canoe reappeared with several gasping men clinging to it. Out of the eleven that had gone down only eight reappeared, and the "little master," as Pocock was called, was not among them. Another belching of the waters disclosed for a moment the insensible form of Pocock. Then Uledi, one of Stanley's bravest followers, struck boldly out for his white brother, but both were sucked down; and this time Uledi, faint and exhausted, alone re-

appeared. A few days later the carpenter of the expedition was carried over Zinga Falls, and perished. He was the fourth member of the party drowned in a journey by river of three miles, the difficulties of which it had taken them thirty days to overcome.

Passing from Zinga, they next encountered the Mbelo Falls, which closely resembled the Lady Alice Rapids. Here, as there, the river was confined between high cliffs; it roared as loudly, and its brownish-white waves were as menacing. The *Lady Alice* was again launched, and its movements cautiously regulated by cables attached to stem and stern, and firmly held by ten men. These cane cables do not appear to have been at all reliable, for at Mbelo, as at the former place, they snapped under the strain, and again the boat, with Stanley and a crew of six, was borne on the crests of wild waves into mid channel, rocks, boulders, and cliffs flying past them with incredible speed. Good luck, however, again attended them, and although they were twice whirled round by the eddying pool, and were once precipitated "into a dancing, seething, hissing caldron, just as if the river was boiling over," they emerged safely in quiet water.

A month later Stanley reached the Fall of Isangila, and as he had now abundant proof that the river he had been tracking to the sea during those



CATARACT OF THE CONGO, DEATH OF FRANK POCKOCK.

weary eight months was the Congo, he saw no further reason to exhaust the rapidly diminishing energy of his company by following any longer the course of the river, there being still four cataracts to pass before the way would be clear. He therefore struck overland for Embomma, a European trading station, where, with the remnant of his expedition, this hero of African travel arrived on August 9th, 1877—the nine hundred and ninety-ninth day from the departure of the expedition from Zanzibar.

The Fall of Isangila, which marked the close of Stanley's journey on the Congo, resembles the other cataracts of this river in being mainly due to a narrowing of the channel and to rocky obstructions in its bed. "The river, which before this," says Mr. H. H. Johnston, who visited the fall in 1883, "has been gliding onwards with deceitful smoothness and a glassy surface, suddenly breaks into white foam and frothy waves, but only that part of it near the base of this cliff; the other half of the great river goes rolling on smooth and unruffled, still mirroring the clouds and the hills, till at length the whole stream takes one great bound over some hidden ledge of rocks, and the mass of this mighty current is lashed and churned into a terrible conflict of waves. Right across its breadth seethes a

zone of dazzling foam, and from the constant oncome and recoil of the masses of water rise tall columns of spray into the air, descending in glittering drops on the tree-covered islands, and forming under the sun's rays fitful gleams of rainbow colours that at first seemed hallucinations." When Stanley saw it there was on the right side of the stream a clear drop of ten feet, and close below it another of eight feet, and then the waters bounded along a wild tempestuous stretch a mile and a half in length.

The next fall on the Congo is the last encountered on the journey by river to the ocean, and it is the one which has been longest known—namely, the Yellala, observed by Tuckey in 1816, and since described by various travellers. Burton visited it in 1863, and does not appear to have been greatly impressed with what he saw. Mr. Johnston visited Yellala in 1883, and has given a very graphic account of the scene. The difficulties encountered in his march overland to the falls were such as to convince him that the sight would never reward him for his exertions.

His first view of the falls was from a hill-top, a sudden turn in the path bringing to his ears a deafening roar of falling water. From a projecting rock he looked down upon the giant Congo some hundred feet below, leaping over the rocks and

dashing itself wrathfully against the imprisoning hills. The river before its first fall came on with smooth and glassy surface; even when it first encountered the rocks in its descent it glided over them almost unresistingly. "Exasperated by repeated checks, however, in the last grand fall of Yellala it lashed itself into white and roaring fury, and the sound of its anger deafened one's ears and the sight of its foam dazzled the eyes."

The traveller would have contented himself with this bird's-eye view, but the old chief who acted as guide insisted on a descent being made to the banks of the river. Here, in a series of caverns on the edge of the water, he could view the falls at his ease. The Congo, he believes, never descends at Yellala more than twelve feet at a time; the constant succession of such falls and the rocky obstructions in the river bed, however, lash the Congo into a state of indescribable fury. "It is," he says, "a splendid race of waves. Some seem to outstrip the others, and every now and then the water, rebounding from the descent, meets the oncoming mass, and their contact sends a shoot of foam and clouds of spray into the air." Here, as at a former fall, the natives set fishing-baskets of wickerwork, and fishermen were seen by Mr. Johnston frying the newly-caught fish for their mid-day meal.

Some Swiss Falls.

THE STAUBBACH.

THE village of Lauterbrunnen lies nestling in a valley so deep and confined that in midsummer the sun does not reach it till seven in the morning, while in winter the same does not happen till noon. The valley is seen at its best after a season of rain, for then the numerous cascades which pour down its precipitous limestone cliffs are in full play. In the heat and drought of summer many of them dry up altogether, while the most famous of them, the Staubbach, is reduced to a tiny rivulet. This is one of the loftiest falls in Europe, and when swollen by recent rains it is one of the most impressive, leaping down as it does in an almost unbroken sheet to a depth of nine hundred and eighty feet.

As seen by the summer tourist, however, the Staubbach is generally disappointing. So small usually is the body of water at that time that



THE STAUBBACH, VALLEY OF LAUTERBRUNNEN.

before it reaches the bottom it is broken up into spray and loses itself in a cloud of vapour. At times also, when the brow of the precipice over which it leaps is hidden in mist, it seems as if it issued from cloudland. For this reason, no doubt, Wordsworth speaks of it as

“This bold, this bright, this sky-born waterfall.”

When seen in the morning sunshine, with the breeze swaying it to and fro, the beauty of the cascade is greatly enhanced by the rainbow hues which then play around it. It is owing to this breaking up of its waters into fine spray that the Staubbach has acquired its name, which signifies “dust-fall.” In winter-time this liquid dust freezes as it falls, and gives origin to a cone of ice that sometimes grows to a height of three or four hundred feet.

FALLS OF THE AAR.

The river Aar takes its rise in two huge glaciers at an elevation of about six thousand feet. It flows down through a bleak and barren valley, over polished granite rocks scratched by the friction of ancient glaciers, and slowly gathering strength until, as it nears Handeck, it has become a roaring torrent. Here also trees and vegetation begin to show, forests of pine clothe its banks, and the infant river makes

its first great dash into civilization by leaping down at a single bound to a depth of two hundred and fifty feet.

Whether regard be had to the height of the fall, to the great volume of its water, or to its wild surroundings, the Falls of the Aar at Handeck are inferior to none in the Alps. The waters are precipitated into a gulf so narrow that the light of day can scarcely penetrate to the bottom. The rebound of the liquid mass after so great a fall causes the spray to rise in a thick cloud from its base, and during the hours of sunshine rainbows form themselves upon it. The effect is still further heightened by the leaping of a second torrent from one side of the same ravine, the waters of which in their silvery clearness contrast with the gray glacier waters of the Aar as they mingle together half-way down in their descent to the self-same gulf.

The poet Wordsworth gives his impression of this fall in the following lines :—

“From the fierce aspect of this river, throwing
His giant body o'er the steep rock's brink,
Back in astonishment and fear we shrink :
But, gradually a calmer look bestowing,
Flowers we espy beside the torrent growing ;
Flowers that peep forth from many a cleft and chink,
And, from the whirlwind of his anger, drink
Hues ever fresh, in rocky fortress blowing :
They suck—from breath that, threatening to destroy,
Is more benignant than the dewy eve—
Beauty, and life, and motions as of joy.”

FALLS OF REICHENBACH.

Near to the village of Meyringen, which lies further down the banks of the Aar, occur the picturesque Falls of Reichenbach. The Wellhorn and the snow-clad Wetterhorn form a grand mountain background to the valley of the Reichenbach, and through it the stream rushes, falling from a height of two thousand feet, divided, however, into three cascades some little distance from one another.

These points of attraction are carefully guarded from the gaze of the tourist until he has paid an entrance fee to the grounds, from which the falls can alone be seen. This preliminary difficulty, however, being adjusted, the visitor forgets his irritation at the petty imposition in his enjoyment of the scene. "I know no spot," says the Rev. Harry Jones, "where the tourist can better study the arrowy character of a waterfall. The stream here is considerable, and takes a fine buoyant header off a shelf of rock upon the hard stone floor of the chasm below. Of course it bursts and splashes off all round with much noise, and flings so much spray up the sides of the basin into which it leaps as to provide materials for a number of baby falls, which run back like young ones to their parent. These cascades make a mist so thick as to wet you through

in a short time ; but the most striking feature in the composition of such a fall as that of Reichenbach is its arrowy character. It is like sheafs of water-rockets rushing downwards. The moment the stream leaps clear of the rock it begins to form these barbed shoots, as if it wished to pierce the stones beneath.

A short distance from these cascades, but on the other side of the valley, is the Fall of the Alpbach. While usually an attractive feature of the village of Meyringen, the Alpbach has occasionally proved a source of danger and destruction. Along with two neighbouring torrents, it brings down with it in time of flood great quantities of mud and stone washed from its banks. This *débris* has been known to accumulate so as to choke for a time the narrow gorge by which it enters the valley of Meyringen. A lake is thus formed, which sooner or later bursts its barrier and covers the village with a deposit of mud. A century ago a disaster of this kind destroyed most of the village, the stones and mud being heaped up in the church to a height of eighteen feet.

FALLS OF THE RHINE.

In point of volume the most imposing falls in Europe are said to be those of the Rhine near



LOWER FALLS OF THE REICHENBACH.

Schaffhausen. The river above the falls is about three hundred and eighty feet broad; and a high ridge of limestone rock which crosses its bed and impedes its course is the cause of the falls. Over this barrier the river precipitates itself in three leaps to a depth of about sixty feet, while if account be taken of the rapids above, the falls have altogether a height of a hundred feet.

It is in greatest volume during the months of June and July, when it is swollen by the melting of the winter snows. Above the falls the water is of a deep blue colour streaked with lines of creamy foam. "Even at a distance the roar of this cataract," says the Rev. H. Jones, "is considerable, and a thousand curdled waves bob about and hurry round the basin into which the stream falls, slapping up against one another's faces, and pausing in odd corners as if they had lost their presence of mind and way at the same time, or were stopping for a minute to look back at the plunge they had just taken, and laugh together at the fright it gave them, before they settled themselves to the journey once more."

There are many points from which the falls can be seen in all their glory. Those who wish to get near them can be conveyed by boat to the huge limestone crag which is situated in the midst of the cataract, and which consequently divides it in

two. The meeting of the eddying waters from either side produces a lane of comparatively still water behind this rock, and along the track thus formed the boatman conveys the tourist. Having reached the rock he mounts it amid a shower of spray, and from the top has the best possible view of the falls.

Those who wish to see them under more comfortable conditions can do so from the beautiful garden of the Schloss Laufen on the left bank. Here a wooden gallery, built against a cliff by the side of the fall, affords an equally good opportunity of appreciating the grandeur of this cataract. "Standing there," says a recent writer, "deafened by the ceaseless roar, splashed by the leaping spray, you begin to appreciate wherein the Falls of the Rhine differ from all others you have seen in Switzerland."

The Falls of Clyde and Foyers.

As might be expected from its mountainous character, the principal British falls are to be found in Scotland—

“Land of brown heath and shaggy wood,
Land of the mountain and the flood.”

The most famous of these are the Falls of Clyde, situated near the town of Lanark. There the Clyde flows through a deep gorge in the old red sandstone rocks—a gorge which at first sight might seem to have been the work of an earthquake, but which Dr. A. Geikie has shown to have been scooped out by the ordinary agents of sub-aerial denudation. “Indeed, one could not,” he says, “choose a better place in which to study the process of waste; for he can examine the effects of rains, springs, and frosts in loosening the sandstone by means of the hundreds of joints that traverse the face of the long cliffs, and he can likewise follow in all their detail the results of the constant wear and tear of

the brown river that keeps ever tumbling and foaming down the ravine."

This gorge extends for about four miles, and in that distance the Clyde descends about two hundred and thirty feet. The descent is chiefly made at three points, which constitute the Falls of Clyde. As the river approaches the upper fall—that of Bonnington—its waters flow slowly, as if in no hurry to enter upon their headlong career. The banks, however, begin to grow steep, and the river making a bend to the north-west its waters suddenly leap over a perpendicular rock into a basin thirty feet below. This fall is unbroken in its descent, and from a rocky islet in the centre of the stream, access to which is obtained by an iron bridge, it is seen to the greatest advantage.

The effect of this upper cascade is somewhat lessened by the comparatively bare and tame character of the banks immediately above it. No defect of this kind interferes with the grandeur of the middle fall—that of Cora Linn—which is generally regarded as the finest of the three. Here tall cliffs rise on either side, clothed to their summits with densest vegetation and with noble trees, whose branches meet across the fall. The ruins of the old castle of Cora, perched like an eyrie on the boldest and highest bank, add still further to the

picturesqueness of the surroundings, amid which the waters of the Clyde throw themselves by three leaps—merged into one when the river is swollen—into the abyss eighty-four feet below.

The Cora Linn is best seen from the bed of the river, access to which is obtained by a rustic staircase partly cut out of the solid rock. "By this," says a local writer, "the traveller descends into a deep and capacious amphitheatre, where he finds himself exactly in front, and on a level with the bottom, of the fall. The foaming waters as they are projected in a double leap over the precipice; the black and weltering pool below; the magnificent range of dark perpendicular rocks, one hundred and twenty feet in height, which sweeps around him on the left; the romantic banks on the opposite side; the river calmly pursuing its onward course; and the rich garniture of wood with which the whole is dressed—combine to form a spectacle with which the most celebrated cataracts in Switzerland and Sweden will scarcely stand comparison."

Above the fall there is a pavilion, raised by Sir James Carmichael in 1708, in which there are a number of mirrors so arranged as to make it appear to the spectator as if the cataract were being precipitated upon him. Wordsworth thus apostrophizes Cora Linn:—

“Lord of the vale ! astounding flood ;
The dullest leaf in this thick wood
Quakes—conscious of thy power ;
The caves reply with hollow moan ;
And vibrates, to its central stone,
Yon time-cemented tower !”

Three miles further down the river occurs the last and largest of the falls—that of Stonebyres. The river on its way thither has broadened considerably, and when it leaps over the precipice it makes a descent of fully seventy feet. Ordinarily it descends, like Cora Linn, in three leaps; but when the river is in flood it presents a single sheet of white foam rushing down into the Salmon Pool beneath. The pool has got its name from the fact that here the salmon is stopped in its journey up stream during the spawning season.

The tourist by the Caledonian Canal has the opportunity given him of visiting one of the loftiest falls in Britain—namely, that of Foyers in Inverness-shire. It is situated on the east side of Loch Ness, and on making his way towards it the traveller soon finds himself surrounded by enormous cliffs, clad with luxuriant vegetation and with pine trees, growing as if out of the solid rock, but having their roots struck deep into its crevices. At the base of these cliffs flows the torrent, which in its short course precipitates itself from considerable heights.

The upper fall is the smaller, being only about thirty feet high, and being broken in two in its descent. A quarter of a mile further down occurs the principal fall, where the waters precipitate themselves in a single sheet of dazzling whiteness to a depth of two hundred and twelve feet. It is known as the "Fall of Smoke," and deserves the name from the cloud of mist and spray that is for ever rising from it. Owing to its great height the Fall of Foyers can be seen a long way off, but it is when standing on the rocky knoll above the huge caldron into which the foaming waters pour that it is most imposing.

The poet Burns visited the place, and as he stood amid the din of the falling cataract he penned, or rather pencilled, the following lines :—

" Among the heathy hills and ragged woods
The roaring Fyers pours his mossy floods ;
Till full he dashes on the rocky mounds,
Where, through a shapeless breach, his stream resounds.
As high in air the bursting torrents flow,
As deep-recoiling surges foam below,
Prone down the rock the whitening sheet descends,
And viewless Echo's ear, astonished, rends.
Dim-seen, through rising mists and ceaseless showers,
The hoary cavern, wide-surrounding, lowers.
Still, through the gap the struggling river toils,
And still, below, the horrid caldron boils."

The Fall of the Doubs.

FROM a cave at the foot of Mont d'Or, among the mountains of Jura, flows the Doubs, a stream which, after an unusually zigzag course of nearly three hundred miles through a highly picturesque country, at last joins the Saone at Verdun. In the early part of its course it frequently disappears, flowing underground for considerable distances; but to the tourist the greatest object of interest on this river is the famous Fall of the Doubs.

After flowing for some miles through a narrow, confined channel, the Doubs expands on reaching the fertile plain of Morteau, where its waters become correspondingly sluggish—a feature which has been perpetuated in the name of *morte eau* given to the village. Beyond this most picturesque of villages the waters of the Doubs collect in Lake Chaillexon, from which the tourist is conducted by boat to the fall.

Before reaching the latter he sails through five

basins, which have been scooped out of the rocky channel of the stream by the action of the rushing water, and which are connected together by narrow passes. In winter, when the ice is strong, the journey can be made in a carriage and pair.

The visitor on his way to the fall is sure to be told the story of the two newly-married people who, taking a pleasure sail on Lake Chaillexon, perceived, when it was too late, that they were caught by the current. Unable to resist its force, they were carried over the fall and disappeared in the gulf below, which never was known to give up its prey.

On entering the first of the five basins which precede the fall, the horizon is seen to be bounded on each side by mountains covered with tall fir trees and shrubs. The right bank is Swiss, the left French; and from the latter, in an angle where the water lies stagnant, words spoken in France are re-echoed distinctly in Switzerland. There, too, Tyrolean songs are wafted across the channel, and return many times with infinite sweetness. Passing through a narrow channel, the second basin is entered,—a regular amphitheatre of perpendicular rocks, forming a fitting frame for the green-coloured water whose still surface looks polished like a mirror. A scale here cut in the face of the rock

marks the varying heights to which the water at different times has risen ; thus, in the year 1801 it rose ten feet, and in 1863 eight feet, above its mean level.

Here the guides love to point out the curious aspect of the projecting rocks, showing how at one place they seem to assume the human form, and at another some more or less fantastic shape. One rock, for example, which stands out prominently against the sky is said to show a double portrait, presenting on one side the head of Napoleon I., and on the other that of Louis Philippe. At another point the rocks look like huge pieces of architecture—gigantic columns and façades—begun by nature in a moment of caprice, and never finished.

The third basin is of an oval form, and the lofty rocks encircling it are clothed to their summits with trees. A colossal rock passed on the left is known as the "Head of Death." The fourth basin is also an amphitheatre of perpendicular rocks. On the Swiss side there is an extensive and undulating meadow, where annually, on a Sunday in the month of July, the dwellers on the banks, both French and Swiss, meet in festive garb, and in the open air celebrate the *fête* of the "Saut du Doubs." In passing into the fifth and final basin the boat enters an immense liquid quadrilateral, with its corners



THE FALL OF THE DOUBS NEAR MORTEAU, FRANCE.

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rounded. On either side is a hotel, and here the visitor to the fall lands. As he makes his way to the fall, the dull roar of the tumbling water breaks on his ear, and the sound gradually grows louder until the spectacle bursts on his sight.

A narrow, grass-covered rock, forming a slight projecting promontory overlooking the fall, affords the spectator an admirable point of view. It is prudent, however, for him to be seated, if he be at all subject to dizziness. To right and left is the abyss, while there swells out in front the crystal sheet of water. At the foot of the perpendicular rock enormous whirlpools of foam are formed, and on the spray—a fine vapour, transparent and sparkling—a rainbow is always smiling. Looking up the river from this point of vantage, one sees at a distance the narrow bed of the Doubs deeply scooped out of the rocks at the foot of the mountains. The cliffs on either side rise to a height of six hundred feet, and are clothed to the summit with fir trees, which raise their tall, pointed heads to the sky, like a forest of lightning conductors.

The waters, as they near the fall, flow along a steep slope, and whirl with great bubbles of snow-white foam around islets of bare, dark-coloured rock. These rocky barriers look as if they wished to arrest the course of the waters on the very edge of

the gaping precipice. Suddenly the solid bed fails it, and the waters of the Doubs plunge furiously into an unfathomable gulf, eighty feet below, where they seem to lose themselves in the bowels of the earth. Nothing absorbed by this watery monster ever reappears at the surface, nor is it ever known to give up the remains of its engulfed victims.

When the Doubs is in flood—and it is very subject to sudden rises—every obstruction disappears under one vast, glassy sheet; when the water is low, on the other hand, the fall dwindles considerably, and then somewhat resembles those Alpine cascades which, falling perpendicularly, break up into spray before they reach the bottom. At ordinary times the fall is divided above by a rocky islet, but both sheets of water reunite some distance below. The people in the neighbourhood affirm that the trout, for which the river is famous, succeed in ascending the fall; but no visitor watching the impetuosity with which the water dashes over the edge of the precipice, and the depth to which it falls, can entertain the belief for a moment.

On regaining the path, the view below the fall is seen to embrace two mountain chains so close together that they, as it were, encase the river as it flows through a cleft from eight hundred to a thousand feet deep. The rapid current of the Doubs in

this gorge supplies the motive power to a large number of manufacturing industries established on its banks. By a narrow track, probably made in the first instance by goats, the visitor, if he is prepared to rough it, can make his way to the foot of the cataract. There it throws its foaming icy spray into his face, the whole accompanied by a noise like thunder, so formidable indeed that the very ground trembles as if moved by subterranean shocks.

The Cascade of Gavarnie.

THE Valley of Gavarnie lies among the grandest scenery in the French Pyrenees. At its lower end is the village of Gavarnie; at its upper, there occurs the finest example known of that curious geological phenomenon—the *cirque*. The inhabitants of these mountains call them *oules*, or “pots,” from their resemblance to huge caldrons.

The Cirque of Gavarnie is a mighty amphitheatre, bounded on all sides by vertical mountain walls of bare rock that rise sheer up for over a thousand feet, and the tops of which are covered with glacier snows. The mode of formation of these cirques is a matter of debate among geologists, many supposing that they have been scooped out by converging streamlets. “They are at least enlarged,” says Dr. A. Geikie, “by this action, and their naked precipices are kept bare and steep by the wedging off of successive slices of rock along lines of joint. Harder bands of rock project as massive ribs down the

slopes, shoot up into prominent peaks, or, with the combined influence of faults and joints, give to the summits the notched, saw-like outlines they so often present." The rocky sides of the Gavarnie cirque show this structure in their horizontal ledges seen at various heights, like "seats for supernatural spectators."

The melting of snow and ice on the lofty fields that lie at the top of the cirque, and on the still greater heights that lie behind, gives origin to mountain streams, that, reaching the edge of the amphitheatre, pour ceaselessly down its precipitous sides in innumerable cascades. The loftiest and greatest of these is that known to travellers as the Cascade of Gavarnie, which, as it falls from a height of thirteen hundred and eighty feet, is believed to be the highest waterfall in Europe.

In spring, after the melting of the snows, it is seen in its full glory, falling as it then does in a broad, unbroken sheet; but as the summer advances, the supply of water grows less, and part of the fall is cut off by a projection of rock.

So lofty are the sides of this cirque that the spectator standing on its floor is unable to see the cluster of mountain peaks which surround it. "All who would become more closely acquainted," says a recent traveller, "with these wild heights must

mount by the slaty, schistose stairs—a natural rock ladder, whereof the rungs are sharp to the hand and insecure to the foot, situated at the right hand corner of the cirque. It is a toilsome and continuous climb upward and upward, past steeply sloping grass pastures, past the springs and sources of waterfalls, winding, zig-zagging, but always ascending—in among stony *débris* and glacier-worn rocks. Finally, a long glacier, inclined steeply against the mountain wall, must be traversed, although a single false step would be followed by swift and inevitable destruction.”

The tourist in the High Pyrenees usually makes the excursion to Gavarnie from the little town of Luz. The chief points of interest on the way, and they are many, are thus noted in an account of a visit made to this celebrated waterfall by Miss Costello. “I have wandered,” she says, “in many lands, and seen much mountain scenery, but I think I never beheld any that approaches the beauty and sublimity of the road to Gavarnie...For some miles the road continues to ascend—in many places a mere horse-track cut in the mountain side, and fenced by a low wall from an abyss of fearful depth, in whose dark cavity is heard the roar of the torrent, which afterwards converts the generic name of Gave into one peculiar to itself. The sides



THE CASCADE OF GAVARNIE.



of the mountains are thickly clothed with box, which grows to a great height, and at this season the autumn tint had given to it the loveliest hues, contrasting well with the dark pines, which climb to the verge of vegetation on the far-off slopes. Suddenly the character of the scene is altered: the road descends, the foliage disappears, or shows itself only in patches in the ravines, and masses of dark gray rock usurp its place; the noisy waters of the Gave make themselves more distinctly heard, and a few rude cottages appear. This is the village of Gèdre...I could have wished to have turned aside at Gèdre to visit the Cascade of Saousa, but Gavarnie beckoned onwards to greater attractions; so again we pursued our route, and I speedily lost all thought for other wonders in the tremendous passes which bear the name of Chaos, and of which the best description can give but a faint and imperfect idea. The huge masses of rock, looking like fallen buildings, which are strown along the valley in inextricable confusion, defy calculation. There they lie, the consequence of some terrific *éboulement*, which must have shaken the mountains to their centre when the mighty ruin was effected. It is supposed that the accident may have occurred in the sixth century, when a fearful earthquake disturbed the Pyrenees; but no written record remains

to attest it. On the first view of this scene of disorder, it seems as if all further progress were stopped; but as we descend among the enormous blocks, a path is found winding through them, which the perseverance of the mountaineer has formed. Emerging from this terrific glen, we abandoned our horses, and after glancing at the Cascade of Ossonne, I passed hastily through the village, and, mounting on a flat rock, threw myself down to gaze upon the stupendous Circus of Gavarnie, which, though still a full league distant, appears at the first glance to be within a quarter of an hour's walk...It required very little exercise of fancy to imagine that we had arrived at the end of the world, so perfectly impassable appeared the barrier which suddenly rose before us. The frowning walls of granite, which form the lowest grade of this vast amphitheatre, rise to a height of twelve hundred feet perpendicularly, and extend to nearly three-quarters of a league, increasing in width as they ascend to the regions of eternal snow, where may be traced a succession of precipices, until they are lost in the bases of the Cylindre and the Tours de Marbore, themselves the outworks of the Mont Perdu, from whose glaciers flow the numerous cascades which in summer shoot from the lower ridge of the circus. The great Waterfall of Gavarnie,

the loftiest in Europe, pours its slender stream from a height of upwards of thirteen hundred feet, on the eastern side of the circus, and in its snow-cold water I dipped my travelling-cup, qualifying with veritable cognac the draught I drank to the health of distant friends."

The Geysers of the Yellowstone Region.

IN comparatively recent geological times the region around the sources of the Yellowstone River was the scene of the most violent volcanic activity. From hundreds of vents, some of which now form peaks ten thousand feet high, there poured in Tertiary times torrents of lava, of scorix, and of ashes. That time of violent Plutonic manifestation has passed away, and the Yellowstone and its tributaries have had time to cut through those fire-formed deposits to depths of from one thousand to two thousand feet.

The subterranean fires, however, have not yet entirely exhausted themselves, but still give evidence of their vitality in those greatest wonders of the American National Park—their hot springs and geysers. These, geologists regard as the escape-pipes or vents for those internal forces which were once so active, but are now so slowly dying out.

On entering the Park from the north the traveller

encounters the hot springs of Gardner's River. He finds himself on a narrow plain with a remarkable mound rising to a height of about two hundred feet, the whole being of such snow-white colour as to remind him of a glacier. It is, however, solid calcareous rock deposited by the hot lime-charged waters of the numerous surrounding springs, and it covers an area of about two square miles.

This mound, known as "White Mountain," is one of the most curious and picturesque sights in the world. It is built up of a series of terraces, some many feet in breadth, others much narrower. These are separated from one another by tiny cliffs from a few inches to six and even ten feet in height. The top is quite level and about a hundred and fifty yards in diameter, and here is situated the principal spring now flowing.

Its basin is about forty feet in length by twenty-five in breadth. The temperature of its waters is 162° F. at the edge, but the heat is probably greater at the point of ebullition. Nothing can exceed its clearness—"clearer than anything," says Lord Dunraven, "I had ever seen before, and of a blue colour marvellous to see. The smallest fleck of cloud floating in the sky is reflected, and the most minute tracery at the bottom of the pool can be distinctly seen."

This water flows over its basin at several points on its rim, and in its descent of the mound it has formed those cliffs and terraces, dotted over with smaller basins, which first collect the water and then let it pass down to the level below. Charged chiefly with lime, the waters as they descend leave the snow-white calcareous deposit behind to which this district owes its form and colour. It has the appearance of a frozen cascade.

"If," says Dr. Hayden, "a group of springs near the summit of a mountain were to distribute their waters down the irregular declivities, and they were slowly congealed, the picture would bear some resemblance in form to White Mountain." Another traveller compares it to a stream pouring over some gigantic staircase that had been suddenly congealed.

Nothing, however, can exceed the beauty of those natural basins that collect the crystal water at each successive fall. Oblong in shape, they are bordered with the most exquisitely fretted rim, the little round concretions of snow-white sinter which cluster all round having the appearance of a circle of pearls. Rich cream is the general colour of the bottom and sides, but these occasionally deepen into bright sulphur yellow, with streaks and patches of vivid red as bright and clear as our brilliant modern mineral dyes, and yet so harmonized and blended.

together that the general effect is by no means harsh or disagreeable.

Springs escape also from the side, and as the water falls from terrace to terrace it gradually cools, so that the bather can get whatever temperature he wishes. In the cooler pools the colour effects are further heightened by the green shades of vegetation. Great quantities also of a silky fibrous substance, apparently vegetable, occur in the streams that flow from the springs; and in the still pools these silken masses become incrustated with lime, and form in one place spongy masses, like delicate coral, and in another a stony fabric as delicate almost as a cobweb.

There are no eruptive springs or geysers visible, the ebullition of the water on the surface of many of the springs being due chiefly to the liberation of carbonic acid gas. There are evidences all about, however, that geysers formerly abounded in the neighbourhood of the Snow Mountain. On the plateau there rises to the height of fifty feet a pillar of sinter twenty feet in diameter at the base. This is known as "Liberty Cap," and is evidently the chimney stalk of a former geyser. The water rising here to a great height had slowly deposited this crust of lime around its sides.

The remains of a smaller one, known as the "Bee-

hive," are close by. This sinter, which is thus incrusting everything that the water of those springs flows over, is neither hard nor compact; and when the water leaves it, atmospheric agencies soon cause it to crumble, until at length the pine-trees which surround this district get a hold and grow up on the new-formed calcareous soil. In other directions, however, the pine forest is being invaded by the sinter, and pine-trees may be seen standing erect, but dead, with six or eight feet of their trunks buried in the deposit.

The water of these hot springs is not unpleasant to the taste, and the district is now visited by large numbers of rheumatic patients, who come to bathe in and to drink of its waters. When Lord Dunraven visited the place there was a shanty which did duty for a hotel at the hot springs of Gardner's River, and three rude huts into which the hot water was led artificially formed the bathing-houses. A few rough boards temporarily nailed together made bathing troughs; but Nature here came to the aid of pioneer art, and by depositing on the rough boards a layer of lime had so given them a coating of white enamel.

A two days' journey brings the traveller from the region of extinct to that of active geysers, while the way between gives abundant indication of the dis-

turbance beneath. "In some parts of the route," says Dr. Geikie, "we seemed to be riding over a mere crust between the air above and a huge boiling vat below. At one place the hind foot of one of the horses went through this crust, and a day or two afterwards, repassing the spot, we saw it steaming."

The Upper and Lower Geyser Basins are situated in the valley of the Firehole River, and occupy an area about a dozen miles in length and from two to three miles broad. The waters of the Firehole River are warm, and warm-water tributaries join it in the geyser region on both sides. Hot springs, spouting geysers, and steaming caldrons are everywhere. "The journey along the valley is suggestive," says Dunraven, "of travelling in, or at any rate towards, and very close to, the infernal regions." His reasons for saying so are embodied in the following racy description:—

"The sides of the river, in fact the whole face of the country, is honeycombed and pitted with springs, ponds, and mud-pots, furrowed with boiling streams, gashed with fissures, and gaping with chasms, from which issue hollow rumblings, as if great stones were rolling round and round, or fierce, angry snarls and roars.

"The ground sounds hollow under foot. The

trail winds in and out among holes that puff sulphur fumes or squirt water at you ; by great caverns that reverberate hideously, and yawn to swallow you up, horse and all ; crosses boiling streams, which flow over beds composed of a hard crust, coloured yellow, green, and red, and skirted by great cisterns of boiling, bubbling, seething water. The crust feels as if it might break through at any moment and drop you into fire and flames beneath, and the animals tread gingerly upon it.

“You pass a translucent, lovely pool, and are nearly pitched into its hot azure depths by your mule, which violently shies at a white puff of steam maliciously spit into its face through a minute fissure in the path. You must needs examine into that ragged-mouthed cavern, and start back with more agility than grace to escape from a sudden flood of hot water which spitefully and without warning gurgles out and wets you through. The air is full of subdued, strange noises, distant grumblings, as of dissatisfied ghosts, faint shrieks, satirical groans, and subterranean laughter, as if the imprisoned devils, though exceedingly uncomfortable, were not beyond being amused at seeing a fresh victim approach. You fancy you can hear the rattle of the loom, the whirl of wheels, the clang and clatter of machinery ; and the impression is borne upon the mind that you

are in the manufacturing department of Inferno, where the skilled hands and artisans doomed to hard labour are employed. I can compare it only to one's feelings in an iron foundry, where one expects every moment to step on a piece of hot iron ; to be run through the stomach by a bar of white, glowing metal ; to be mistaken for a pig and cast headlong into a furnace; or to be in some other way burned, scalded, and damaged."

Entering the valley from the south end, the Upper Geyser Basin is reached, and the first of the geysers met with is that known as "Old Faithful," a name given it because it can be relied upon for having an eruption at regular intervals of about half an hour.

The mound upon which the crater stands rises about thirty feet above the surrounding plain, the crater itself being five or six feet higher. The mound measures about two hundred and fifteen feet by one hundred and forty-five feet at the base, and is composed of successive sheets of sinter, which narrow as they ascend, giving the whole a terraced appearance not unlike the hot springs of Gardner's River. As in the latter, little pools and basins are scattered here and there on its surface, filled with hot water, the perfect transparency of which is demonstrated by trappers and others who write their names on pieces of the sinter, drop them into the water, and

leave them there to be read by all who look down into those pellucid fountains. The practice, it must be confessed, savours somewhat of the vandalism which cuts initials on monuments of all sorts, natural and artificial.

The chimney of the crater, about eight feet high, is built up of curious nodular concretions, these again being covered with smaller stalagmitic balls, and the whole incrustated with a thin glazing of silica. Within this hollow lies the vent, not more than a couple of feet in diameter. Steam is always issuing from this, but, as already stated, once every half-hour it becomes more demonstrative.

As premonitory of the coming eruption, its waters begin to surge up and down with a gurgling sound. Occasional jets of water are thrown up, each spasm of the imprisoned element becomes more powerful, and at last with a tremendous roar it shoots up into the air a mighty column of water and steam to a height of from a hundred to a hundred and fifty feet. This continues for about five minutes, the top of the column all the while being maintained at about the same level. The great mass of the water falls directly back into the basin and flows over the edges and down the sides in large streams.

The eruption ceases as suddenly as it began, and for fully half an hour nothing is heard of it beyond



"OLD FAITHFUL" FIREHOLE VALLEY, NATIONAL PARK.

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the ceaseless gurgling of water in its throat. After the usual interval it is as demonstrative as ever, and this has gone on since the discovery of the geysers, sixteen years ago, with a regularity that fully entitles it to the name of "Old Faithful." The mound which surrounds this geyser is brilliant with the weird volcanic tints of that region, and the effect is greatly heightened when, streaming with water from the geyser, the sun shines upon the many-coloured deposits.

Near "Old Faithful," but on the other side of the river, stands the "Beehive." It is a silicious cone about three feet high and five feet in diameter at the base, with an oval vent measuring about two feet by three feet. When first seen by Dr. Hayden's party it was not supposed to be a geyser at all, as it was only on the morning of their departure that they found its eruptive capacity.

When they were at breakfast they were startled by the sudden shooting of a column of water from the "Beehive." The column filled the entire orifice, and rose to a height of two hundred and nineteen feet. This continued for eighteen minutes, and such was the velocity of the water that the column was not deflected more than four or five degrees from the perpendicular. The water did not appear to fall back, but seemed to be broken up and

diffused through the atmosphere as fine spray or steam.

On the same side of the river, but about one hundred yards further back from it, is the much more imposing geyser called the "Giantess." Its crater, situated on a considerable mound, has an opening thirty-two feet by twenty-three feet, and when not in eruption the water may not rise within sixty feet of the surface. When first seen by Dr. Hayden's exploring party no water could be discovered in it at all. It could, however, be heard distinctly gurgling and boiling far below, and soon its quiescence came to an end. "Suddenly it began to rise, boiling and spluttering, and sending out huge masses of steam, causing a general stampede of our company, driving us some distance from our point of observation. When within about forty feet of the surface it became stationary, and we returned to look down upon it. It was foaming and surging at a terrible rate, occasionally emitting small jets of hot water nearly to the mouth of the orifice. All at once it seemed seized with a fearful spasm, and rose with incredible rapidity, hardly affording us time to flee to a safe distance, when it burst from the orifice with terrific momentum, rising in a column the full size of this immense aperture to the height of sixty feet; and through and out of the apex of this vast aqueous

mass five or six lesser jets or round columns of water, varying in size from six to fifteen inches in diameter, were projected to the marvellous height of two hundred and fifty feet. These lesser jets, so much higher than the main column, and shooting through it, doubtless proceed from auxiliary pipes leading into the principal orifice near the bottom, where the explosive force is greater...This grand eruption continued for twenty minutes, and was the most magnificent sight we ever witnessed. We were standing on the side of the geyser nearest the sun, the gleams of which filled the sparkling column of water and spray with myriads of rainbows, whose arches were constantly changing, dipping and fluttering hither and thither, and disappearing only to be succeeded by others, again and again, amid the aqueous column; while the minute globules into which the spent jets were diffused when falling sparkled like a shower of diamonds; and around every shadow which the denser clouds of vapour, interrupting the sun's rays, cast upon the column could be seen a luminous circle, radiant with all the colours of the prism, and resembling the halo of glory represented in paintings as encircling the head of Divinity. All that we had previously witnessed seemed tame in comparison with the perfect grandeur and beauty of this display. Two of these wonder-

ful eruptions occurred during the twenty-two hours we remained in the valley."

There are three geysers on the other side of the river that call for notice—the Castle, the Giant, and Young Faithful. The Castle Geyser is the largest and most imposing formation in the valley. It looks to the traveller as he approaches like the ruins of an old castle; hence its name. The silicious deposit here forms a platform one hundred feet in length and seventy feet broad, and from its centre there rises the chimney to a height of about twelve feet. The latter is built up of silica which has deposited itself in immense globular masses that have been compared to cauliflowers or spongiform corals. These form rough steps by which the traveller climbs to the edge of the funnel.

Around the crater are several pools, the water of which comes and goes in sympathy with the main geyser. One of these specially impressed Lord Dunraven by the intense clearness of its waters. It was about sixty feet deep, but with an aperture at the bottom so profound "that you might almost fancy it went through to the other side." So clear and still is its surface that one has to plunge in his hand in order to tell which is air and which water.

When seen by the first explorers of the region it was observed to throw out every few moments a

column of water to the height of ten or fifteen feet. They had evidently not seen it in one of its more imposing eruptions. Dr. Geikie was fortunate in seeing the "Castle" in 1880 in magnificent eruption. It hurled a much greater body of water into the air than did "Old Faithful," and the display lasted double the time.

In addition to the main column of water there rose from it rocket-like projectiles of water and steam, shot out from it, and which burst into a shower of drops outside. He had been sitting sketching near by when the eruption began, and in three minutes the place where he had been sitting was the bed of a rapid torrent of hot water.

Lord Dunraven saw it in still greater commotion. The noise which immediately preceded the eruption he compares to a rumbling of thousands of tons of stones rolling round and round, piling up in heaps and rattling down again. As the noise grew louder, the geyser would belch out a few tons of water. This continued at intervals, the noise constantly increasing, until finally with a mighty spasm a great column of water was hurled into the air. It rose, he estimates, to a height of two hundred and fifty feet, while the steam and spray rose still higher and floated away as cloud.

The water was driven up by a series of frequent

pulsations, which increased in force until the display had reached its climax, when they gradually lessened. Long after the water had ceased to rise steam was expelled in prodigious quantities and with immense force. The total display lasted for an hour, water being ejected for about twenty minutes.

The "Giant" is one of those geysers whose force is evidently waning. The large rugged chimney of its crater and the immense platform on which it stands tell something of its former greatness. According to Professor Hayden it throws a column of water the size of the opening to a height of one hundred and thirty feet, and continues the display for an hour and a half. Later travellers who have seen it in eruption speak of it now as throwing up a column of water only for a few minutes at a time.

Close to it a new geyser has lately appeared, which is in constant eruption—a constancy which has gained for it the name of "Young Faithful." "I threw him some stones," says Lord Dunraven,— "an attention which he rather seemed to appreciate, for he rolled them about in his throat, and did not reject them until he had ground them to powder." This young giant is constantly gaining strength, evidently at the expense of the old "Giant" close to it, who will probably ere long be added to the number of extinct geysers.

Among many other geysers in the Upper Basin that have had names given to them and their motions described, three more may be noticed—namely, the “Comet,” the “Fan,” and the “Grand Geyser.” The “Comet” was discovered by Colonel Barlow, and he and his party had the satisfaction of seeing it several times in eruption.

It has three openings, the chief one being about twelve inches by eighteen inches in diameter. From this the water, generally once a day, but not perfectly regular, rises to a height calculated by Colonel Barlow at over two hundred feet. “The roar,” he adds, “was like the sound of a tornado, but without apparent effort—a steady stream, very graceful and perfectly vertical—except as a slight breeze may have waved it to and fro. Strong and smooth, it continued to ascend like the stream from a powerful steam fire-engine. The display of water-works lasted for twenty minutes, and was succeeded by the violent puffing of steam from the throat of the geyser, as well as from the other openings about.

Not far from the “Giant” Geyser is the curious vent known as the “Grotto,” so called from the arches, pillars, and turrets of its enclosing walls. Mistaking it for a grotto, the early explorers made their way through its silicious arches. Fortunately for them it was not for an hour after they had got

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clear of this irregularly-formed chimney that an eruption took place, in which a column of water six feet in diameter was ejected to a height of sixty feet.

Nearly opposite the "Grotto," but on the other side of the river, is the exceedingly graceful "Fan" Geyser. It has a double opening, and from this there play five radiating jets of water to a height of sixty feet, the fan-like appearance of the eruption being due to the shower of spray and water-drops which fall in all directions. It is frequently in eruption, the display usually lasting from ten to thirty minutes at a time.

There still remains to be noticed what Lieutenant Doane calls "the Grand Geyser of the World." It is one of a group of fifty hot springs and geysers occurring a little below the "Castle." It is situated on the summit of a bank of stalagmitic rock, and its vent, which has only a rim of a few inches in height, measures twenty feet by twenty-five feet. This well when quiet has a visible depth of one hundred feet.

"When an eruption is about to occur," says Lieutenant Doane, "the basin gradually fills with boiling water to within a few feet of the surface; then suddenly, with heavy concussions, immense clouds of steam rise to the height of five hundred feet, and



THE GROTTO, FIREHOLE VALLEY, NATIONAL PARK.



the whole great body of water, twenty feet by twenty-five feet, ascends in one gigantic column to the height of ninety feet. From the apex of this column five great jets shoot up, radiating slightly from each other, to the unparalleled altitude of two hundred and fifty feet from the ground. The earth trembles under the descending deluge from this vast fountain; a thousand hissing sounds are heard in the air; rainbows encircle the summits of the jets with a halo of celestial glory. The falling water ploughs up and bears away the shelly strata, and a seething flood pours down the slope and into the river. It is the grandest, the most majestic, and most terrible fountain in the world. After playing thus for twenty minutes it gradually subsides, the water lowers into the crater out of sight, the steam ceases to escape, and all is quiet. This Grand Geyser played three times in the afternoon, but appears to be irregular in its periods, as we did not see it in eruption again while in the valley. Its waters are of a deep ultramarine colour, clear and beautiful. The waving to and fro of the gigantic fountain, in a bright sunlight, when its jets are at their highest, affords a spectacle of wonder of which any description can give but a feeble idea. Our whole party were wild with enthusiasm; many declared it was three hundred feet in height, but I have kept, in

the figures as set down above, within the limits of absolute certainty."

Professor Hayden was equally lost in wonder and admiration at this geyser, which, as its power seemed greater than that of any other in the valley, he called the Grand Geyser. The eruption, according to his account, was preceded by a tremendous rumbling and shaking of the ground and the issuing of a column of steam from the orifice. Following the steam there came, by a series of impulses, a column of water apparently six feet in diameter and two hundred feet high, the steam ascending a thousand feet more.

The column was maintained so steadily as to appear solid, the water returning into the basin "in millions of prismatic drops." For twenty minutes the warm aqueous column was maintained at this great height, the rumbling and confusion attending upon it being comparable only "to that of a charge in battle." In the one basin there are two orifices. The one is the Grand Geyser, already described; the other and larger orifice is never altogether quiet, and every twenty minutes its waters rise to a height of ten or fifteen feet. Dr. Hayden could not find that these vents, although quite close to each other, had any connection. Disturbance in the one does not affect the equanimity of the other.

This want of sympathy between contiguous craters was taken notice of by Dr. Geikie during his visit to the region in 1880. At the summit of a mound the top of the subterranean column of boiling water can be seen about a yard from the surface in a constant state of commotion; while at the base of the mound, at a level thirty or forty feet lower, lie quiet pools of steaming water, some of them with a point of ebullition in their centre. There can be no direct connection between these pipes. Their independence is still more strikingly displayed at the time of eruption; for while the geyser is spouting high into the air, these surrounding pools go on quietly boiling as before. It is now generally acknowledged that the seat of eruptive energy is in the underground pipe itself, each geyser having its peculiarities of shape, depth, and temperature. But it would appear also that at least above this seat of activity there can be no communication even between contiguous vents on the same geyser mound. The Lower Geyser Basin is somewhat tame to the traveller who has sated himself with the wonders of the Upper Basin; nevertheless it contains springs and geysers which in any other part of the world would be considered extraordinary.

Looking at the basin from an eminence, columns of steam are seen to arise from a thousand vents.

The view reminded Dr. Hayden of some manufacturing city like Pittsburg seen from an elevation, only instead of the black coal smoke there were here the delicate white clouds of steam. To Dunraven it conveyed the impression as of some modern Sodom and Gomorrah which had suddenly sunk into the earth amid flames, and that the smoke of their ruins was still ascending through white heaps of smouldering ashes.

The springs with which this valley abounds spread their silicious deposit far and wide, owing to their habit of dying down at one spot and breaking out anew at another. Fields of this silicious snow can be seen where now there is no spring, and dotted over its surface are forlorn-looking pine-trees dead and incrustated with the prevailing mineral. On the other hand, trees in the neighbourhood of active springs may still be seen, whose waters have not yet had time to kill them, although they are evidently dying by inches.

The feature of the Lower Valley is its numberless springs, with their beautifully-coloured basins. These are formed of deposits, chiefly of silica and iron, and occasionally of sulphur—the varying quantities in which these ingredients occur in different springs giving them an infinite variety of colouring. The water, clear as crystal, though often, owing to depth

and other causes, it sometimes looks blue, sometimes green tinted, is always hot. Dr. Hayden, exploring the region, says that his party were like Coleridge's mariner on the ocean, with "water, water everywhere, but not a drop to drink."

These springs petrify whatever vegetable or even animal substances are subjected long enough to the action of their waters. This is not merely an incrustation of silica; but as the vegetable tissue rots its place is taken by mineral matter until the whole is turned into agatized wood. Petrified pine cones are thus often fished from these mineral springs, and butterflies and grasshoppers which have fallen into the springs and been scalded to death have also been found in a more or less petrified condition.

There are at least six springs in the Lower Basin, which at longer or shorter intervals project a stream of water into the air, and can consequently be termed geysers. One at least of these will bear comparison with the giants of the Upper Basin. Its circular basin is about sixty feet in diameter, although the spring itself in the centre of this is only about half that size. Its waters are of a blue colour, and are in a constant state of ebullition. At intervals it spouts, throwing a column of water one hundred feet into the air.

The Fountain Geyser is a more strikingly beauti-

ful form. Within a basin one hundred and fifty feet in diameter there rises a crater just above the surface, the ring of rock resembling one of those circular coral islands in the Pacific Ocean. From this crater the water is thrown up in a vast column to a height of fifty feet. This column slopes outward as it ascends, causing the water when at its full height to bend gracefully over like the fronds of a palm, and thus to fall back into the outer basin in a thick shower of silver-white globules.

The Mud Geysers are also a feature of the Lower Basin. Near the Thud Geyser, so called from the peculiar noise it makes as it rises and falls, there are three mud springs, in one of which the mud is red, in another white, and in the third pink, the colour being due to the presence of iron in varying quantities. The jets of steam that rise through these mud pools cause them to bubble up and form blister-like domes on the surface.

The most remarkable of these curiosities is the one situated near the Fountain Geyser. Its pot measures about forty feet by sixty feet, and it is full of a fine silicious mud of every colour, from white to pink. This large surface is constantly rising into huge blisters, which, as they explode with a dull thud, throw the mud some feet into the air. "These mud-springs and caldrons," says Lord Dun-

raven, "form the comic part of the entertainment. There is something very ludicrous about them. They fuss and fume and splutter and spit in such a rage about nothing, and with such small results, and are withal so dirty and undignified, that one feels quite inclined to laugh at them."

Surely there is no region in the world that is half so wonderful as the National Park on the Yellowstone, with its awful cañons and splendid cataracts, its hot-water rivers and springs, its silicious deposits, its picturesque geysers, and its droll mud caldrons. As yet it has only been looked upon by the adventurous; but the railway is now on its confines, and in a few years there is little doubt "this region will be a place of resort for all classes of people from all portions of the world."

The Geysers of Iceland.

"High in the frozen North where Hecla glows,
And melts in torrents his coeval snows ;
O'er ices and oceans sheds a sanguine light,
And shoots red stars amid the ebon night ;
When at his base entombed, with bellowing sound
Fell Geyser roared, and struggling shook the ground ;
Poured from red nostrils, with her scalding breath,
A boiling deluge o'er the blasted heath."

IMPINGING as it does on the Arctic Circle, and suggestive as its name is of glacial conditions, Iceland possesses the hottest springs of the Old World. It is a region of intense subterranean activity that shows itself in the most varied forms.

Now it is Mount Hecla ejecting lava and ashes until the atmosphere of the whole island is darkened, and the dust from it powders the fields in the north of Scotland. At another time it is an earthquake shock, during which rocky skerries disappear and new islands arise. But at all times the traveller in Iceland can reckon upon observing its geysers in more or less eruptive action.

These are found in the district of Haukadal, about sixty miles distant from Hecla. On a small

plateau, in the midst of magnificent scenery, consisting of lofty mountains clad in everlasting snow, and with glaciers that stretch downward towards the lava-covered plain, five miles in length and three miles in breadth, and composed for the most part of silicious sinter deposited from the waters that well up over its surface, occur numerous hot springs.

Some of these are quiescent or constantly boiling pools, in which visitors may carry on cooking or washing operations. These pools may either be geysers in an initial stage of their existence or they may be geysers in the last stage of decrepitude. The other springs are those which alone deserve the name of geyser—an Icelandic word meaning *roarer*. These are spouting fountains which, at longer or shorter intervals, throw up considerable volumes of water into the air.

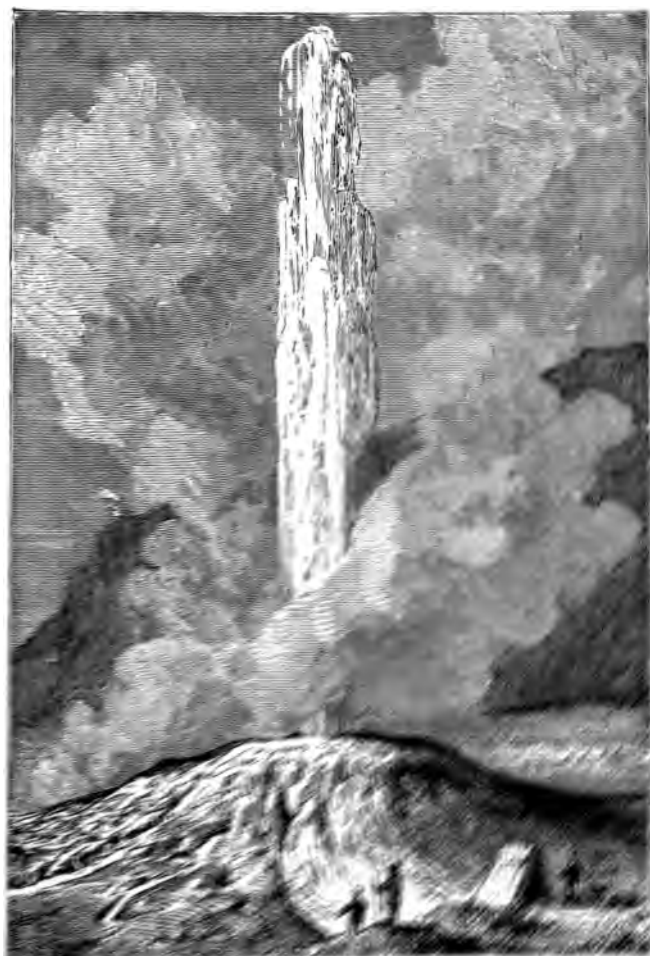
The most famous of these aqueous volcanoes are the Geyser or *Roarer*, and the Stroker or *Churn*. The earliest mention of these Iceland geysers occurs in Norwegian records of seven centuries ago; but, strange to say, no notice is taken of them by Icelandic writers till the middle of the seventeenth century. The Bishop of Skelholt at that time refers to The Geyser, and states that it had an eruption once every twenty-four hours.

A h ' ' years later Olafsen and Povelsen

visited The Geyser and found that it had three or four eruptions daily, and that the column of water ascended to a height of three hundred feet. Its basin, they found, measured about fifty-seven feet in diameter, and the depth of the tube in the centre seventy-two feet. Since that time there has been a succession of observers at intervals of a few years, and the accounts given by them show that, in the frequency of its eruptions and in the height to which it raises its aqueous column, The Geyser is subject to considerable variation.

Thus Von Troil, in 1772, estimated the height of the column at ninety-two feet; Stanley, in 1789, at ninety-six feet; and Hooker, in 1809, at a hundred feet. The latter found The Geyser erupting at intervals of thirty hours; while Henderson, in 1815, found the eruptions taking place at intervals of six hours, and its column rising occasionally to a height of one hundred and fifty feet. Of late years The Geyser does not appear to have been so active as in the earlier part of the century, its outbursts not usually occurring oftener than once in thirty hours, and the height of its jet averaging only seventy or eighty feet. When visited by Burton in 1872 no eruption took place.

Near the northern extremity of the igneous platform already referred to stands The Geyser. It



THE GREAT WHITE MONUMENT

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consists of a large and almost circular mound formed of silicious deposits about forty feet in height. The top forms a basin measuring fifty-two feet from north to south and about sixty feet from east to west. This saucer-like hollow is lined with a beautifully white silicious plaster, almost perfectly smooth, and hard enough to resist the blows of a hammer.

From the centre of this basin a tube ten feet in diameter descends to a depth of seventy-four feet. Both tube and basin are believed to have been built up by the geyser itself. How this has been done is thus admirably described by Professor Tyndall:—"If we place a quantity of geyser water in an evaporating basin the following takes place: in the centre of the basin the liquid deposits nothing, but at the sides where it is drawn up by capillary attraction, and thus subjected to speedy evaporation, we find silica deposited. Round the edge a ring of silica is laid on, and not until the evaporation has continued a considerable time do we find the slightest turbidity in the middle of the water.

"This experiment is the microscopic representative of what occurs in Iceland. Imagine the case of a simple thermal silicious spring whose waters trickle down a gentle enclosure: the water thus exposed evaporates speedily and silica is deposited. This deposit gradually elevates the side over which

the water passes, until finally the latter has to take another course. The same takes place here: the ground is elevated as before, and the spring has to move forward. Thus it is compelled to travel round and round, discharging its silica and deepening the shaft in which it dwells, until finally, in the course of ages, the simple spring has produced this wonderful apparatus which has so long puzzled and astonished both the traveller and the philosopher."

It has been calculated that in building up this tube and basin The Geyser has been engaged for ten or eleven centuries. Commander Forbes, who visited Iceland in 1859, arrived at that conclusion on the following grounds: he found that a coating of silica as thick as a fine sheet of paper was deposited during twenty-four hours on a tuft of grass placed under a small fall of geyser water; that five hundred of these sheets gave a thickness of an inch; and as the tube of the geyser was seven hundred and sixty-two inches thick, that it must have taken about one thousand and thirty-six years to build it up.

Such is the origin of the tube and basin of The Geyser. What are the phenomena of which they are the arena? These have been described by a multitude of travellers, some only of whom, however, have been fortunate in observing The Geyser at its best—that is, during any of its great eruptions.

Visiting it in 1814, Henderson found The Geyser in play every six hours. Soon after reaching the geyser mound, premonitory symptoms of an eruption were given in loud reports resembling the distant discharge of a park of artillery, that shook violently the ground on which he stood. He had scarcely time to look into the basin when the fountain exploded and compelled him to retire to a respectful distance to windward.

"The water," he says, "rushed up out of the pipe with amazing velocity, and was projected by irregular jets into the atmosphere, surrounded by immense volumes of steam. The first four or five jets were inconsiderable, not exceeding fifteen or twenty feet in height; these were followed by one about fifty feet, which was succeeded by two or three considerably lower; after which came the last, exceeding all the rest in splendour, which rose to at least the height of seventy feet."

Large stones which he had previously thrown into the tube were ejected to a great height, in one case much higher than the column of water. The latter had a diameter of about ten feet; but the grandly picturesque effect of the play of this gigantic fountain was greatly heightened by the division of the originally perpendicular column into a number of "the most superb curvated ramifications."

Vast clouds of steam accompanied the eruption and continued to roll and spread as they ascended till they filled the entire horizon, and completely eclipsed the sun, which at the time was shining brightly. He found the temperature of the water in the basin after the eruption to be 183° Fahr., or nearly 20° less than when the basin was filling immediately before the outburst. Another eruption on the same day lasted for eight minutes ten seconds—the longest he saw. The jets were also much higher than before, although none exceeded a hundred feet.

On his return from the north of the island in the following year, Henderson, during his two days' stay, found the operations of the Great Geyser still more magnificent, the water rising in jets to a height of one hundred and fifty feet.

Sir William Hooker, who visited the geysers in the summer of 1809, gives a very similar account of the eruptions seen by him of the Great Geyser. These were frequent, and in some cases rose to a height of not less than ninety feet. The base of this aqueous column, he says, was nearly as wide as the basin itself—that is, about fifty feet. "The bottom of it," he adds, "was a prodigious body of white foam. Higher up, amidst the vast clouds of steam that had burst from the pipe, the water was seen mounting in a compact column, which at a still

greater height burst into innumerable long and narrow streamlets of spray that were either shot to a vast height in the air in a perpendicular direction, or thrown out from the side diagonally to a prodigious distance."

As a botanist Hooker was specially interested in the vegetation of the geyser region. He found certain plants growing in spots so much heated by subterranean streams that he could scarcely bear his hands upon the ground. Where the waters of the geyser joined those of a cold stream, every blade of grass and every leaf or bit of moss washed by these mineral waters was coated with a delicate silicious covering. Some were so beautifully incrustated as to appear like models of the plants in plaster of Paris.

Half a century later this region was visited by Commander Forbes, who has given one of the most detailed and scientific accounts of geyser phenomena. He found that often three days elapsed without any great effort being made by The Geyser; but he was fortunate in witnessing more than one of these.

One morning it sounded an unmistakable reveille which would have roused the dead, and he had only time to get into a good position for viewing it when "full power was turned on. Jet succeeded jet with fearful rapidity, earth trembled, and the very cone itself seemed to stagger under the ordeal. Portions

of its sides, rent with the uncontrollable fury it had suddenly generated, were ripped off and flew up in volleys, soaring high above water and steam.... Discharge succeeded discharge in rapid succession for upwards of four minutes. When apparently exhausted and its basin empty," he scrambled up the margin to have a look down the tube; but the basin he found again nearly full, and he had scarcely got back to his former position when the most magnificent explosion of all took place. "Everything seemed to depend on this superhuman effort, and a solid unbroken column of water was hurled upwards, twenty-five feet in circumference, and attaining an altitude of nearly a hundred feet."

Mr. Symington was fortunate in observing one of the most prolonged eruptions of the Great Geyser on record in modern times. The usual subterranean noises ushered in the outbreak. It began very mildly, the water in the basin rising first in great bells, until at last one burst, and jets of water then rushed upwards in sheaves from the tube. Each spurt rose higher than its predecessor, until at last the jets rose to a height of two hundred feet. "The fountain," he says, "did not fall down between each jet, but, nearly holding the elevation once gained, the whole grew up bodily by a series of jerks, each higher than the last."

The white vapour which spread over the fountain condensed in the cool upper air, and came down like heavy dew, while the noise was loud and continuous, reminding him of the roaring of an angry sea broken in upon by the near discharge of minute guns. The whole spectacle lasted about twenty minutes.

The Stroker or Churn, which is the next most important geyser, stands two hundred yards distant from the Great Geyser. It was first mentioned by Stanley, who visited the region in 1789. At that time it was throwing up a vast column of water to a height of one hundred and thirty feet, and had consequently excelled its better-known neighbour. An earthquake later on in the same year, altering as it did the course of its subterranean channel, brought its career to an end. The name of Stroker was then transferred to the geyser which now bears the name.

Although generally inferior to the Great Geyser, the Stroker now and again surpasses it. The chief difference between them, however, according to Lord Dunraven, is that Stroker can always be excited by feeding him with turf and stones; whilst Geyser spouts just when he chooses, "and will not allow himself to be deranged by any insult whatever."

Henderson was the first to discover this ready means of precipitating an eruption. This was in

the year 1815, and his method has since been amply verified. By regulating the quantity of stone and turf thrown into it, Commander Forbes could even arrange as to the time when the eruption might be expected. On one occasion he cooked a dinner for himself and some friends in the Stroker!

He first gave it a dose of turf and stone that would act in about forty minutes. Then he packed a breast of mutton securely in the body of his shirt and a ptarmigan in each sleeve, and threw it into the gurgling throat of the geyser, the arrangement being that in forty minutes, when it would be properly cooked, it would be ejected. "The forty minutes passed," he says, "and I became nervous regarding the more substantial portion of the repast, and fearing lest the Stroker had digested my mutton, ordered turf to be piled for another emetic. But seven minutes after time my anxiety was relieved by a tremendous eruption, and surrounded with steam and turf clods, I beheld my shirt in mid air, arms extended....After about a quarter of an hour, in a temporary lull, I recovered my garment, and turned the dinner out on the grass. The mutton was done to a turn."

There have been many theories regarding the origin of the tremendous force exhibited in those aqueous eruptions. It is now the generally accepted

view that the geyser power lies wholly in the tube. It has thus been explained by Dr. A. Geikie :— “Bunsen and Descloiseaux spent some days experimenting at the Icelandic geysers, and ascertained that in the Great Geyser, while the surface temperature is about 212° Fahr., that of lower portions of the tube is much higher—a thermometer giving as high a reading as 266° Fahr. The water at a little depth must consequently be 54° above the normal boiling-point; but it is kept in the fluid state by the pressure of the overlying column. At the basin, however, the water cools quickly. After an explosion it accumulates there and eventually begins to boil. The pressure on the column below being thus relieved, a portion of the superheated water flashes into steam, and as the change passes down the pipe, the whole column of water and steam rushes out with great violence. The water thereafter gradually collects again in the pipe, and after an interval of some hours the operation is renewed. The experiments made by Bunsen proved the source of the eruptive action to lie in the hot part of the pipe. He hung stones by strings to different depths in the funnel of the geyser, and found that only those in the higher part were cast out by the rush of water, while at the same time the water at the bottom was hardly disturbed at all.”

Geyzers of New Zealand.*

NEW ZEALAND has been called the Britain of the South; but in one respect at least it differs greatly from the mother country—namely, in being the scene, at the present day, of intense volcanic action. Near the centre of North Island rise the two active

* Since the following account was written, a great catastrophe has befallen the geyser region of New Zealand. Mount Tarawera—a volcano in the centre of the hot lake district, which had slumbered so long that the Maories had not even a tradition of its ever having been in eruption—suddenly, on the morning of June 10th, 1886, burst into awful activity, belching out lava and fire to a great height. The top of Mount Tarawera was, according to one account, blown literally into the air, and thousands of blocks of glowing lava resembling great fire-balls were ejected with a sound resembling the firing of great guns at sea. Soon afterwards the volcano began to pour out ashes in such quantity as to completely darken the heavens over a wide area. An observer 150 miles from the scene saw this ashy column rising into the air, and estimated its height at not less than 22,000 feet. The effect of this terrific shower of dust, scorise, ashes, and mud, was most disastrous for miles around Tarawera, every building over a wide area being crushed by the weight of the falling material. About one hundred Maories are known to have perished in the neighbourhood of Rotomahana, as well as several European settlers at Wairoa, including one English tourist. The hot lake district has undergone an immense transformation. Both the Pink and White Terraces are believed to have been destroyed, while the romantic Lake Rotomahana is said to be now nothing more than a hole of seething mud and vaporous gases.

volcanoes of Tongariro and Ruapehu, which, when not more actively engaged, emit endless columns of smoke.

From these smoky sentinels there extends, in a north-easterly direction, for a distance of about one hundred and fifty miles, a broad tract of country resembling in many respects the Yellowstone Region of America. It is a region of hot lakes, geysers, solfataras, boiling springs, and mud volcanoes; and although they do not seem to be so demonstrative as their American congeners, they are in some other respects more remarkable.

The basins or funnels of some of the New Zealand geysers are very large, and this is usually an index of the rank of a geyser. The largest cistern in the Firehole Basin of the Yellowstone is, according to Lord Dunraven, two hundred and fifty feet in diameter; while Lake Rotomahana, the water of which is raised to a high temperature by the hot springs which burst through the bottom and sides, and may therefore be regarded as a single cistern, is a mile in length and a quarter of a mile broad.

The greater part of the geyser region of New Zealand is still in possession of the native Maories, consequently it has not been much visited by

It is, however, being gradually opened

up for the tourist by the laying of roads, the running of coaches, and the erection of hotels. The sulphur, mud, and other mineral baths of the Rotorua and Rotomahana districts are already credited with many marvellous cures of chronic disease, and it is confidently predicted that the geyser region of New Zealand will ere long become the sanatorium of the southern world.

This is the opinion of Froude, the famous historian, who visited the region in the year 1884. He describes the bathing establishments at Ohinemutu as "rows of unbeautiful wooden buildings, lodging-houses, reading-rooms, bath-rooms. The water of the springs had been taken possession of and distributed by pipes, part into deep, open, swimming pools enclosed by palisades, part taken under roof into large square cisterns with dressing-closets round the edges and steps from them into the water. 'Madame Rachel' was one of them—clear as crystal, but alkaline to nastiness, and so charged with silica that if you stayed in long enough you would be enamelled. A small twig which had been left in for a week or two was like a branch of white coral." Another bath, which had cured a priest of rheumatism, "tasted like a strong solution of sulphuric acid, and smelt most potently of sulphuretted hydrogen. There is no reasonable

doubt, however, that the healing virtue, whatever it be, that lies in hot mineral springs exists in a supreme degree in these waters at Ohinemutu. Here will be the chief sanitary station of the future for the South Sea English. The fame of it will spread, and as transit grows more easy, invalids will find their way there from all parts of the world. This desert promontory, with its sad green lake and Maori huts and distant smoke columns, will hereafter be an enormous Cockney watering-place; and here it will be that in some sanitarian *salon* Macaulay's New Zealander, returning from his travels, will exhibit his sketch of the ruins of St. Paul's to groups of admiring young ladies."

To reach the geyser district it is usual to start from Tauranga, a seaport about one hundred and twenty miles from Auckland, and only about forty miles by road through a plain of diluvial pumice to Lake Rotorua. The eastern side of this lake is the principal seat of volcanic agency, and here at Ohinemutu are two small hotels. Here the banks of the lake are honeycombed with countless boiling springs; and on a small peninsula in the midst of them is placed a Maori settlement. This place is said to have been chosen by the natives owing to the facilities it afforded for cooking with the least possible trouble to themselves. "Every hut," says

Mr. Martin in a recent account, "has its boiler worked by nature as close to the door as is deemed convenient; and kits or baskets of potatoes, fish, beef, and other edibles, are suspended in these pools until ready for table. Over some of the hottest portions of the ground large slabs of stone are placed, on which, covered by moist grass or weeds, bread is baked; on other slabs, not quite so hot, the lazy recline themselves, and, wrapped or covered with a blanket, enjoy Vulcan's heat on the coldest day. If abundance of hot water thus encourages laziness in the natives, it also encourages cleanliness, as both sexes are to be seen at all times luxuriating in the water."

The necessity of labouring in order to obtain the necessities of life does not affect these Maories, as the revenue they draw from government and from tourists amply suffices. "They own the district," says Froude, "as a village community. The government rents it of them. They live on their income like ladies and gentlemen, and having no work to do, or not caring to do any, they prefer to enjoy themselves. They dig out baths, bring streams from cold springs to temper the hot, and pass half their time lounging in the tepid water. I heard a grunt as I passed one of these pools. I supposed it was a pig. Looking round, I beheld a copper-

coloured face and shoulders, a white head, and a pipe sticking out of the mouth. They find existence very tolerable on these terms. Old men, women, and children paddle about all day; young men swim in the warm corners of the lake. Now and then some small boy or girl falls into a boiling hole, and the parents are relieved of further trouble with them."

The ground in those tongues of land that jut out into the lake is so perforated with springs as to be thoroughly unreliable, and accidents through the giving way of the crust are not uncommon. The natives show the place where an entire village went down some years ago and disappeared in the lake, carrying all the inhabitants with it.

About a mile beyond the hotel, on the banks of the lake, is Sulphur Point—a plateau of sinter incrustated here and there with sulphur crystals, and abounding in hot sulphurous pools and mud-holes. "One mud-bath that we ventured into," says a recent visitor, "certainly did not look tempting: great waves of thick brown mud bubbled up in the middle of the pool and rolled lazily towards the sides. It was just a pleasant temperature, very smooth and oily, and, notwithstanding its appearance, deci

One pool is known as "Painkiller," owing to its reputed virtue in curing rheumatism; and although as a rule a perfectly safe bath to enter, on a recent occasion it nearly proved fatal to a young English bathér. One of the large bubbles for ever forming on its surface burst, and the poisonous gases being blown in his face rendered him insensible. Had a friendly Maori, who happened to be standing near, not observed his condition, he would certainly have been drowned.

A mile further along the side of the lake occurs one of the few New Zealand geysers which have been actually seen in eruption by Europeans. It had been dormant since 1869, when in April 1878 it suddenly burst out into renewed activity. Fortunately an English traveller, Mr. Clement Bunbury, was visiting the place at the time, and he has given an account of this unusual phenomenon. As in most other geysers, it rises in the midst of a circular basin about thirty feet in height, formed of silicious material, and having roughly the appearance of white marble. "After being quiescent for a few minutes, the water began to leap up through the circular cavity at the top of the cone, and rising higher and higher at each leap, at last culminated in splendid volumes of clear, bright boiling water thrown fully forty feet into the air. Dense masses

of steam floated from the water in mid-air ; but the column of water itself fell so nearly perpendicularly that we were able to stand as near to it as the intense heat would permit. After playing for about five minutes, the fountain gradually subsided, to take a rest lasting about eleven minutes before its next display."

On the opposite side of Lake Rotorua are the famous Tikitiri springs. These are remarkable for their size and their dismal appearance, the water being dark-coloured and the sulphurous fumes rising from them dense and penetrating. One of these is over a hundred feet in diameter, and boils with a fury that appals the spectator.

According to a recent visitor to this spot, huge billows of water were forced upward and dashed about the pool ; but so dense was the steam that only a peep at the turmoil could be gained now and again. It is called Hurutani by the natives, after a Maori woman who fell into this scalding Maelstrom, and was literally boiled to shreds. The fumes of sulphurous acid arising from those waters soon discolour any silver ornaments that the visitor may wear.

Near this are a series of eight boiling mud-springs, the largest ten feet in diameter, each pulsating and sputtering forth a thick saponaceous mud of a dark

lead colour from their cup-like craters formed of layers of mud. The ground for many miles round the shores of Rotorua everywhere bears evidence of volcanic activity beneath. For some distance the traveller makes his way over a plateau of silica that reverberates beneath his feet, and that has a temperature of 100° Fahr., while at intervals there are openings in this crust which show him how little solid matter there is between his feet and the molten matter below.

Another flat expanse is known as the "Sulphur Cups," from the dome-shaped cups which everywhere stud its surface, and in which water and sulphur gently bubble. The "Cream Cups" Flat, in the same neighbourhood, is covered with small cup-shaped excrescences of the purest sulphur, each of these being a tiny sulphur spring. Some of the geysers around Rotorua remind one of the Icelandic Stroker on a small scale, inasmuch as they can be tickled into eruption, sods thrown into them generally acting as an emetic.

The white sinter terraces of Rotomahana are the great sight of the New Zealand geyser region, and to reach these the traveller crosses in a southeasterly direction from Rotorua to Lake Tarawera and the village of Wairoa, a distance of not more than fifteen miles. Here the natives provide whale



TERRACE OF ROTOMAHANA, NEW ZEALAND.
Before the Eruption of June 20, 1883.

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boats for the conveyance of visitors to Rotomahana.

The latter is a small lake about a mile square, the waters of which, owing to the hot springs in its bed and to the hot streams that flow into it, enjoy a high temperature. On its eastern shore rises the white terrace of Rotomahana. It lies on the side of a mountain that has all the appearance of having been at one time a volcano, jets of steam still rising from all parts of it.

The terrace rises to a height of one hundred and fifty feet, and looking at it either from top or bottom, it resembles a huge fan-like crystal staircase, the upper steps of which have a length of about three hundred feet, while the bottom ones are nearly twice as long. At the summit the cause of all this picturesque incrustation is found in the huge caldron of boiling pale blue water, from which dense clouds of steam rise and help to obscure its surface. It is about ninety feet in diameter, and of a depth estimated at from twenty to forty feet. "It is," says Mr. Martin, "always hissing and boiling, and possesses a temperature varying from 210° Fahr. to 214°, according to its activity. It is so quiet at times that a daring adventurer can walk around its lip or even descend a few feet into its nearly empty basin; but it will suddenly and with

terrific violence break into activity, and throwing up an enormous column of water fill its basin to overflowing, and perhaps forcibly eject the whole contents in one convulsive eruption, throwing the water to a height of forty or fifty feet, to the certain destruction of any one who has dared to come within reach of its scalding fountain.

Its waters are highly silicious, and articles which the curious visitor exposes to its action soon become covered over with a delicate coating of white sinter. Enclosed in a basin of purest white, this geyser or fountain pours its boiling waters over the side, and these, flowing down the face of the hill—which beneath the incrustation is found to consist of tufa and pumice—have, by the deposit of their superabundant mineral matter, given rise to this most charming of Nature's sights.

From the top downwards there may be counted forty distinct terraces, each of a somewhat semi-circular form, and separated from each other by a fall varying from a few inches to ten or twelve feet. The water flowing down from the topmost platform enters the basins with which each of these gigantic steps in this great staircase is studded. These basins seem as if made of purest alabaster, and the effect is heightened by the sapphire, turquoise, or azure waters with which they overflow

the trickling streams as they pass over the sides incrusting them with the most lovely festoons of sinter.

These perpendicular faces of the steps are the most strikingly beautiful part of the sight, one traveller comparing the incrustations to the most delicate representations of flower and fruit carvings or soft white coral sprays; another, to bunches of fruit and nosegays of flowers faultlessly sculptured. The water, which leaves the top at a boiling heat, gradually cools as it descends from tier to tier of the terrace, so that the bather can select whatever temperature he wishes.

Behind the white terraces there is abundant evidence that the traveller is on a hill of fire. Immense volumes of steam issue with tremendous force and noise from numerous holes, and here and there may be seen mud geysers for ever sputtering about their semi-liquid contents. The mud of one of these was said to have been eaten by the Maories as medicine. It has a slightly sweet acidulous taste.

On the way to the ferry by which the traveller is conveyed across the lake to the other great sight of this locality—the pink terraces—two geysers are passed. The one, *Nga Hutu*, spouts steam and hisses terribly at all times, and occasionally also throws great masses of boiling water to a height of

over twenty feet. The other is Kakarike, with a basin fifty feet in diameter, in which the boiling water rolls about in great waves that dash against its sides and are occasionally lifted up bodily to a height of twenty feet.

The pink terrace lies against a hill much higher and steeper than that on which the white terrace is laid. It is broken into about fifty distinct steps, separated from each other by perpendicular walls about six feet in height. At the top is the geyser whose overflowing waters have produced this gorgeous effect of deposited silica. The temperature in this case is about 20° lower than in the geyser which crowns the summit of the white terrace. The thin vapour hovering over its surface is almost transparent, and a light breeze is sufficient to brush it aside. "Standing on the edge under these favourable conditions, we could gaze," says Mr. Froude, "as through an opening in the earth into an azure infinity beyond. Down and down, and fainter and softer as they receded, the white crystals projected from the rocky walls over the abyss till they seemed to dissolve not into darkness but into light. The hue of the water was something which I had never seen and shall never again see on this side of eternity. Not the violet, not the harebell, nearest in its tint to heaven of all Nature's flowers, not tur-

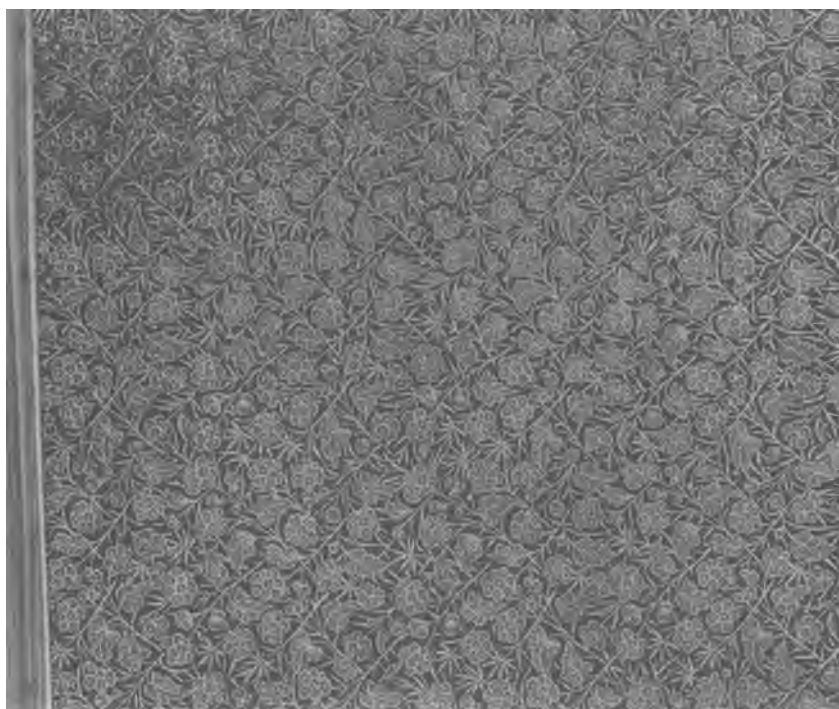
quoise nor sapphire, not the unfathomable ether itself, could convey to one who had not looked on it a sense of that supernatural loveliness. The only colour I ever saw in sky or on earth in the least resembling the aspect of this extraordinary pool was the flame of burning sulphur. Here was a bath, if mortal flesh could have borne to dive into it! Had it been Norway we should have seen far down the floating Lorelei inviting us to plunge and leave life and all belonging to it for such a home and such companionship. It was a bath for the gods and not for man. Artemis and her nymphs should have been swimming there, and we Actæons daring our fate to gaze on them." A trace of oxide of iron in its waters is believed to explain the salmon-pink colour of the sinter. It is less extensive than the white terrace and much less varied in its formation, the steps being for the most part flat and with few of those basins of azure water which so beautify the other.

There are, however, five basins used as bathing pools, and these, according to one account, form the most luxurious baths that can be imagined, the temperature being graded, and the inner surface having a soft feeling like satin or velvet. In the deepest of these pools Mr. Froude bathed, the water having a temperature of 94° or 95°. "The water," he says,

“was deep enough to swim in comfortably, though not over our heads. We lay on our backs and floated for ten minutes in exquisite enjoyment, and the alkali or the flint or the perfect purity of the element seemed to saturate our systems. I for one, when I was dressed again, could have fancied myself back in the old days when I did not know that I had a body, and could run uphill as lightly as down.” On the smooth upper steps visitors frequently write their names in pencil, and in a day or two they are covered with a thin transparent coating of silica, which will no doubt preserve them for ages. The pink deposit is now being formed very slowly, names which were thus inscribed thirty years ago being still quite visible under the thinnest glaze, so that it is highly probable that both pink and white terraces were formed at a time when these waters yielded a much larger quantity of silica.

THE END.

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Great waterfalls, cataracts an

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